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PHYSICS ABSTRACTS

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SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 2352–3380

VOLUME 58 **APRIL 1955** NUMBER 688

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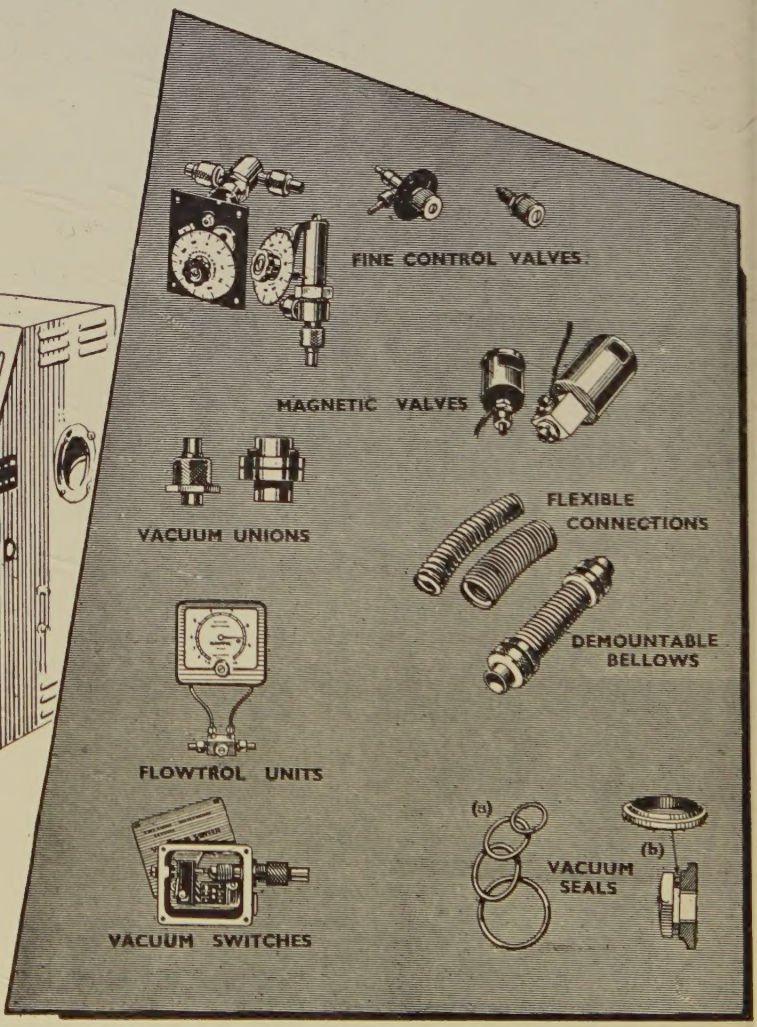

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Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplements published with the Indexes to Volumes 56 (1953) and 57 (1954). Reprints of the List of Journals (1953) and the Supplements (1953 and 1954) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

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Scientia Sinica	Formerly *Acta Scientia Sinica.*

Notes

Acta Scientia Sinica	Title changed to *Scientia Sinica* starting with Volume III, No. 3 (1954).
Tellus	Address changed to Svenska Geofysiska Föreningen, Institute of Meteorology, University of Stockholm, Lindhagensgatan 124, 5 tr., Stockholm K.

Errata

Author Index (1952), p. 1205, column 1: The entry "Note on Schwinger's variational method, 777" under K. KATO should be under T. KATO.

Author Index (1954) p. 1554, column 2, line 10: *for* GUINANO, S. *read* GUINAND, S.

p. 1656, column 1, line 42: *for* GUINANO, S. *read* GUINAND, S.

Abstr. 5333 (1954), line 2: *for* A. HUETZ *read* AUBERT-HUETZ.

Abstr. 7242 (1954), line 8: *for* and were *read* was.

The pages of *Acustica*, Volume **4**, Number 4 (1954) were wrongly numbered, and the pages given in the following abstracts should be altered to the numbers shown, to agree with the revised numbering announced by the publishers:

Abstr. 10844 (1954), line 3: *for* **4**, 407–10 *read* **4**, *No.* 4, 475–8.
Abstr. 10901 (1954), line 3: *for* **4**, 403–6 *read* **4**, *No.* 4, 471–4.
Abstr. 10903 (1954), lines 2 and 3: *for* **4**, 432–8 *read* **4**, *No.* 4, 500–6.
Abstr. 10904 (1954), line 2: *for* **4**, 411–20 *read* **4**, *No.* 4, 479–88.
Abstr. 10905 (1954), line 2: *for* **4**, 441–6 *read* **4**, *No.* 4, 509–14.
Abstr. 10907 (1954), line 3: *for* **4**, 439–40 *read* **4**, *No.* 4, 507–8.
Abstr. 10908 (1954), line 3: *for* **4**, 447–50 *read* **4**, *No.* 4, 515–18.
Abstr. 11687 (1954), line 4: *for* **4**, 421–31 *read* **4**, *No.* 4, 489–99.
Abstr. 141 (1955), line 2: *for* 450 *read* 518.

Abstr. 26 (1955), line 2: *for* $g_{\mu\nu}{}^{+-}j_\rho$ *read* $g_{\mu\nu}{}^{+-};_\rho$.

Abstr. 384 (1955), line 16: *for* 1400 *read* 140.

Abstr. 527 (1955), lines 2 and 3: *for* L. B. MAGNUSSEN *read* L. B. MAGNUSSON.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 3131 (1950): **9a**, *No.* 12, 1056 (*Dec.*, 1954).
Abstr. 5040 (1952): **23**, *No.* 2, 399 (*Feb.*, 1955).
Abstr. 5518 (1953): **25**, *No.* 5(11), 632 (1953).
Abstr. 4653 (1954): **9**, *No.* 6, 1037 (*Nov.–Dec.*, 1954).
Abstr. 4877 (1954): **96**, *No.* 6, 1713 (*Dec.* 15, 1954).
Abstr. 6864 (1954): **96**, *No.* 6, 1713 (*Dec.* 15, 1954).
Abstr. 7671 (1954): **96**, *No.* 6, 1713 (*Dec.* 15, 1954).
Abstr. 9456 (1954): **96**, *No.* 6, 1714 (*Dec.* 15, 1954).
Abstr. 9894 (1954): **40**, *No.* 9, 870 (*Sept.*, 1954).
Abstr. 9981 (1954): **9**, *No.* 5, 881 (*Sept.–Oct.*, 1954).
Abstr. 11450 (1954): **96**, *No.* 6, 1714 (*Dec.* 15, 1954).
Abstr. 11452 (1954): **96**, *No.* 6, 1714 (*Dec.* 15, 1954).
Abstr. 353 (1955): **68**, *Pt* 1, 58 (*Jan.*, 1955).
Abstr. 584 (1955): **23**, *No.* 1, 221 (*Jan.*, 1955).
Abstr. 587 (1955): **23**, *No.* 2, 398 (*Feb.*, 1955).
Abstr. 1103 (1955): **23**, *No.* 2, 401 (*Feb.*, 1955).

MATHEMATICS 51

513.76

2352. Geometric representation of the Gudermann transformation. R. CAZENAVE. *Ann. Télécomm.*, **9**, *No.* 12, 330–3 (*Dec.*, 1954) In French.

It is shown that the transformation is homographic, and is produced by a transformation, by reciprocal polars, of the unit circle into a branch of an equilateral hyperbola. It is also produced by a certain homographic transformation of the unit circle into itself. L. S. GODDARD

517.5

2353. On spheroidal functions. T. AOI. *J. Phys. Soc. Japan*, **10**, *No.* 2, 130–41 (*Feb.*, 1955).

Some mathematical properties of spheroidal functions satisfying the differential equation of the form $d/dz\{(1-z^2)dZ/dz\} + (\lambda + \kappa^2 z^2)Z = 0$ are investigated. One solution, $\mathrm{pe}_n(z)$ regular at $|z| = 1$, which has already been known as a special case of the generalized spheroidal function $\mathrm{pe}_n^m(z)$, is developed into a Legendre expansion and its coefficients are obtained explicitly for several cases. The solution of the first kind $\mathrm{Re}_n(z)$ and that of the second kind $\mathrm{Se}_n(z)$, which are valid especially when $z \gg 1$, are defined by definite integrals and are also expressed in series form in terms of modified Bessel functions. An alternative expression for $\mathrm{Se}_n(z)$, which is conveniently used even when z is not so large, is also defined in like manner as in the case of the derivation of the modified Mathieu function $\mathrm{FEK}_n(z)$ or $\mathrm{GEK}_n(z)$. Further, the asymptotic behaviour of these functions $\mathrm{Re}_n(z)$ and $\mathrm{Se}_n(z)$ is obtained. A.

517.86

2354. Loci of several elementary transcendental functions. H. WAHL. *Frequenz*, **8**, *No.* 11, 346–51 (*Nov.*, 1954) In German.

The known theory of rational algebraic functions of real variables with complex coefficients is briefly reviewed. The exponential function $\exp(pZ)$ of a real variable p with complex coefficient Z is then studied in detail including the distribution of p along the locus and the location of special points such as axis crossings, etc. The properties of radius vector and tangent vector are also described. A rapid yet sufficiently accurate form of curve construction is given using the circle of curvature at axis intersections. For special values of Z the locus reduces to a circle or half of a straight line. The sine function is then treated with the same thoroughness as a rational function of the exponential function. Detailed solutions are given of two examples. S. C. DUNN

517.864

2355. On the zeros of certain transcendental functions related to Hankel functions. I–II. M. NAGASE. *J. Phys. Soc. Japan*, **9**, *No.* 5, 826–41, 842–53 (*Sept.–Oct.*, 1954).

517.946

2356. Numerical treatment of a fourth order parabolic partial differential equation. S. H. CRANDALL. *J. Assoc. Comput. Mach.*, **1**, *No.* 3, 111–18 (*July*, 1954).

Finite difference approximations to solutions of $\partial^4\psi/\partial x^4 + \partial^2\psi/\partial t^2 = 0$ can be obtained using either an explicit or implicit recurrence formula. The implicit formula is presented here, and its properties are studied and compared with the explicit. Theoretical and numerical comparisons indicate the superiority of the former, particularly for large intervals Δt, where the explicit procedure leads to faster build-up of error. N. M. KING

517.946.9

2357. Contribution to the theory of upper and lower bounds in boundary value problems. H. FUJITA. *J. Phys. Soc. Japan*, **10**, *No.* 1, 1–8 (*Jan.*, 1955).

Certain approximate methods concerning self-adjoint operators H of Hilbert spaces which can be expressed in the form $H = T^*T$ are developed. Some theorems are formulated with remarks and examples. They give a method of obtaining upper and lower bounds of the value of the solution, at each preassigned point, of a boundary value problem. As a numerical example the following Poisson's equation is considered, $-\Delta u = 1$ in D, $u = 0$ on C, where D denotes the square domain in the xy-plane with vertices at (1, −1), (1, 1), (−1, 1), (−1, −1) and C is the boundary of this square. Upper and lower bounds of the value of the solution u at the origin are calculated. The result of the second approximation is $0{\cdot}2939 \leqslant u(0, 0) \leqslant 0{\cdot}2953$. In order to show that the results are applicable to many problems, several differential operators familiar in mathematical physics, for instance, Laplace's differential operators with different boundary conditions, are reduced to the form T^*T. A.

518.42

2358. Elegant methods of summarizing an experimental curve: the search for a mathematical form, the condition of regularity. Application to extrapolation. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1605–7 (*Dec.* 8, 1954) In French.

It is emphasized that in spite of the apparent regularity of the curve it is almost impossible to determine an exact mathematical relation owing to the insufficient number of experimental points. However, the representative mathematical expression obtained by smoothing and using successive differences is of assistance when extrapolation is required. S. WEINTROUB

518.5

2359. A method for solving boundary value problems of mathematical physics on punch card machines. S. BERGMAN. *J. Assoc. Comput. Mach.*, **1**, *No.* 3, 101–4 (*July*, 1954).

Points out that a simple programme can be prepared for general computations occurring in the preparation of a set of particular solutions of

$$\tfrac{1}{4}(\partial^2 u/\partial x^2 + \partial^2 u/\partial y^2) + a(\partial u/\partial x) + b(\partial u/\partial y) + Fu = 0$$

with a, b, F, entire functions of x and y. The case of $a = b = 0$ is treated here, and extensions of the method indicated. N. M. KING

518.5 : 519.241.1 : 621.372.54 : 621.317.79

2360. A new method of determining correlation functions of stationary time series. D. G. LAMPARD. *Proc. Instn Elect. Engrs, Monogr. No.* 104 R, publ. *Aug.* 16, 1954 (**102C**, 35–41).

For abstract, see Abstr. 10723 (1954).

518.5 : 531.721

2361. Errors of friction wheel integrators. J. G. L. MICHEL. *J. sci. Instrum.*, **32**, *No.* 2, 43–4 (*Feb.*, 1955).

Sharp-edged friction wheels moving across hard surfaces with a combined rolling and sliding motion are used as units for integration in a number of instruments varying in complexity from planimeters to differential analysers. In these applications it is assumed that, providing the bearing friction of the wheel is sufficiently small, the rotation of the wheel is a true representation of that component of its motion across the surface which is tangential to the wheel. This paper shows that, for finite bearing friction (however small), this is not true when there is any non-tangential (sliding) motion of the wheel; an expression is adduced for the amount of error, with a numerical example of the magnitude of this error in a type of integrator used in differential analysers. It is pointed out that errors due to this cause may always be reduced to negligible proportions in the case of the differential analyser, at the expense of increasing the time of solution. A.

518.5 : 539.434 : 621.3.012.8 : 621.372.2

The physical and computing significance of an electrical analogue of creep and recovery. *See Abstr.* 3197

519.2

2362. Coding to achieve Markov type redundancy. J. E. FLANAGAN. *J. Math. Phys.*, **33**, *No.* 3, 258–68 (*Oct.*, 1954).

A contribution to information theory. By incoming text is meant a discrete, finite-range, stationary stochastic process. The paper presents a study of the problem of block coding incoming text in an inefficient manner so that the resulting 0,1 channel stochastic process is close (in a certain sense) to a preassigned 0,1 discrete stationary Markov α-process. This is interpreted as an attempt to combat noise in the channel by introducing redundancy in the form of Markov α-dependency. L. S. GODDARD

ASTRONOMY . ASTROPHYSICS . GEODESY 52

523.164

2363. Methods and results of radio astronomy. II. H. SIEDENTOPF. *Z. angew. Phys.*, **6**, *No.* 9, 422–30 (1954) In German.

Continuation of Abstr. 10 (1955). Summary of observations of (*a*) the diffuse radiation of the Milky Way and the extragalactic background radiation, (*b*) the emission of the 21 cm line by interstellar hydrogen, and the spiral structure of the galaxy, (*c*) the radar observation of meteors, (*d*) radio echoes from the moon, and the thermal radiation of the moon, and (*e*) radio scintillation and the structure of the ionosphere. M. W. OVENDEN

523.164

2364. Special report on interstellar hydrogen. *U.R.S.I. Special Rep., No.* 4–5, 53–71 (1954).

Report of committee set up at Sydney, 1952. A discussion of the observational data relevant to the emission (or absorption) line of H at 21 cm ($\nu = 1420$ Mc/s). In addition to a brief introduction (section I), the report contains, *inter alia*, the following sections comprising a useful summary of recent work: (III), measuring equipment; (IV), significance of the 21 cm observations; (V), methods of determining the H distribution; (VI), line profiles in the galactic plane; (VII), temperature and optical depth; (VIII), galactic rotation; (IX), random motions; (X), density distribution in the galactic plane; (XI), distribution of peak intensities of the 21 cm line; (XII), regional studies; and (XIII), extragalactic observations. A list of 6 stations engaging in 21 cm line research is included. D. R. BARBER

523.164

2365. Charge separation by currents in ionized gases and cosmic radiofrequency radiation. R. W. LARENZ. Note in *Naturwissenschaften*, **41**, *No.* 20, 470–1 (1954) In German.

523.165 : 537.591

2366. On the origin of cosmic radiation. H. ALFVÉN. *Tellus*, **6**, *No.* 3, 232–53 (*Aug.*, 1954).

The "local" theory of the origin of cosmic radiation is developed. According to the theory the radiation (possibly with exception of the highest energies) is generated in interplanetary space around the sun and trapped in an interstellar magnetic field. The acceleration takes place in electromagnetic fields in the sun's environment which are produced by the solar activity and especially associated with magnetic storms. A theory of the origin of cosmic radiation should at the same time be a theory of the extra-terrestrial variations in the radiation. The present theory incorporates the magnetic storm variation, the diurnal variation and the long time (solar cycle) variation. The acceleration process of the theory is efficient for protons and especially for heavy nuclei but is inefficient for electrons. This explains the absence of electrons in the primary cosmic radiation. The latitude "knee" is accounted for as a direct effect of the acceleration process. A.

523.5

2367. A table for the calculation of meteor velocities. J. G. DAVIES. *Jodrell Bank Ann.*, **1**, *No.* 3, 58–67 (*June*, 1954).

The velocity of a meteor, determined by the diffraction effect with pulsed beam, is given by $V = ky/p$, where k is a known constant for a given equipment, p is the number of pulses in the measured Fresnel zone, and y depends upon the range of the echo and the appropriate Fresnel integrals. The tables give the value of y for given range and zone spacing. The range is tabulated in intervals of 5 km from 100 km to 900 km, and the tables can be used for all possible zone spacings up to the eleventh maximum of the diffraction pattern. M. W. OVENDEN

523.5

2368. Periodic influx of interplanetary dust particles into the terrestrial atmosphere. P. K. SEN GUPTA. *Indian J. Meteorol. Geophys.*, **5**, *No.* 3, 272–6 (*July*, 1954).

A brief account is first given of available evidence on the influx of interplanetary dust particles into the terrestrial atmosphere, viz., presence of sodium at high altitudes, appearance of noctilucent clouds, pitting of polished surfaces during high altitude rocket flights, high nickel content in deep sea sediments and periodic occurrence of heavy rainfall in association with meteor showers. These dust particles have sizes of the same order as of those which account for the outer corona of the Sun, but terrestrial evidences suggest a higher concentration in the vicinity of the Earth. Discussing the processes which are responsible for the high concentration of dust particles, it has been suggested that solar corpuscular streams push interplanetary dust particles towards the Earth by repeated impacts. This mechanism is expected to give rise to an accumulation of dust particles near the Earth, as well as in the plane of ecliptic. A.

523.5 : 537.564

2369. Collision processes in meteor trails. H. S. W. MASSEY AND D. W. SIDA. *Phil. Mag.*, **46**, 190–8 (*Feb.*, 1955).

Extensive data on the probability that an evaporated meteor atom will produce an electron in an ionizing collision before being brought to rest are now available. To obtain from these data values of the ionization cross-section for impacts between meteor atoms and atmospheric molecules the momentum loss cross-section for elastic impacts of this kind must be known. These latter cross-sections are calculated for roughly representative collisions in which the interaction between a meteor atom and a gas molecule is taken to be that between calcium and neon atoms calculated statistically. Values for the ionization cross-sections are then derived and found to be consistent with the recent theoretical considerations of Bates and Massey [Abstr. 3615 (1954)]. The diffusion of ionization in a meteor trail is also discussed in relation to known observed data on the mobility of positive ions in gases. A.

523.72

2370. The distribution of radio brightness on the solar disk. *U.R.S.I. Special Report, No.* 4–5, 1–46 (1954).

Report of committee set up at Sydney, 1952. Methods of measuring the intensity of radio emission from the whole solar disk, and from different parts of the solar disk (by eclipse observations, interferometric and pencil-beam aerials, and the occultation of a radio star by the solar corona) are discussed, and the observational results on centimetric, decimetric and metric wavelengths given. The bias of the report is experimental, but a section is devoted to the relation of the observations to the physics of the Sun. 80 references are listed. M. W. OVENDEN

523.72

2371. Fine structure of solar radio transients. G. REBER. Letter in *Nature* [*London*] **175**, 132 (*Jan.* 15, 1955).

These are shown to consist of discrete pips and the duration of a pip is shown to be approximately equal to the wavelength in metres. The frequency band of a pip was also found to be narrow. J. M. HOUGH

523.73

2372. Remarks on a temporal variation of the law of rotation of the sun. U. BECKER. Note in *Naturwissenschaften*, **41**, *No.* 23, 549 (1954) In German.

Analysis of the positions of sunspots tabulated in the *Greenwich Photoheliographic Results* for the years 1900–30 inclusive, reveals that at the commencement of each spot cycle the high-latitude spots rotate faster than they do around the epoch of maximum activity. Conversely, low-latitude spots observed at the close of a cycle rotate slower than do those in the same latitude at maximum. These results contradict those of Newton and Nunn (1951), but they confirm the observed decrease of rotational velocity with increasing phase of the spot-cycle derived from spectroscopic data. D. R. BARBER

523.755

2373. Photometric and polarimetric observation of the solar corona during the total eclipse of the sun of Feb. 25, 1952. The coronal isophotes. M. CIMINO. *R.C. Accad. Naz. Lincei*, **17**, *No.* 1–2, 21–5 (*July–Aug.*, 1954) In Italian.

See Abstr. 995 (1954).

523.755

2374. Optical and radioelectric observations of the total solar eclipse of 25 February, 1952. I. Photometric and polarimetric observations of the outer corona. R. MICHARD, A. DOLLFUS, J.-C. PECKER, M. LAFFINEUR AND M. D'AZAMBUJA. *Ann. Astrophys.*, **17**, *No.* 5, 320–44 (*Sept.–Oct.*, 1954) In French.

A detailed account of the photographic apparatus used at the total eclipse of 25 February, 1952, in Khartoum. "Polaroid" polarizing filters were employed, and the images of the solar disk and inner corona were occulted by diaphragms placed in the focal plane of the camera. The photographs obtained in red light revealed a coronal jet on the solar E limb whose light was 80% polarized. Radial polarization of the corona could be detected out to > 4 solar diameters, and its value varied from 20% to 5%, outwards from the sun's centre. D. R. BARBER

523.755

2375. Optical and radioelectric observations of the total solar eclipse of 25 February, 1952. II. Monochromatic photographs of the corona. R. MICHARD, A. DOLLFUS, J.-C. PECKER, M. LAFFINEUR AND M. D'AZAMBUJA. *Ann. Astrophys.*, **17**, *No.* 5, 345–57 (*Sept.–Oct.*, 1954) In French.

Images of the corona in light of Fe XIV (5303 Å), and Fe X (6374 Å) respectively were obtained at Khartoum using a Lyot polarizing filter, and image-separator attached to small refractor, rel. aperture, f 10. The separate photographs were photometered, and the results used to study the variation of emission with position angle, and distance from the sun's limb. The monochromatic images were directly compared with those obtained in integrated (white) light by Waldmeier at the same eclipse. The 5303 Å image closely resembled that for white light, except for enhanced contrast; whereas the 6374 Å image showed

conspicuous differences, interpreted as being due to relatively cool regions in the lowest coronal level where the red radiation was relatively intense. The same series of photographs was used to compare with radioelectric observations (following abstract).

D. R. BARBER

523.755

2376. Optical and radioelectric observations of the total solar eclipse of 25 February, 1952. III. Radioelectric observations of the corona. M. LAFFINEUR, R. MICHARD, J.-C. PECKER AND B. VAUQUOIS. *Ann. Astrophys.*, **17**, *No.* 5, 358–76 (*Sept.–Oct.*, 1954) In French.

The radioelectric isophotic diagrams were obtained with a specially-constructed radio-telescope (working at 555 and 255 Mc/s). It was found that the pattern for 555 Mc/s followed closely the optical pattern for 5303 Å, both radiations being proportional to N_e^2. Similarly, the 255 Mc/s pattern was compared with the optical data, and it was evident that the isophots corresponding to this frequency extended further from the sun's limb than did the 555 Mc/s pattern. The photometric measures of the two radioelectric patterns conform with the interferometric results of Stanier and O'Brien (1950). Superposed clouds of enhanced radio-emission coincided with bright 5303 Å patches, thus exhibiting a certain similarity of optical and radio data. D. R. BARBER

523.755

2377. The irregular structure of the outer regions of the solar corona. A. HEWISH. *Proc. Roy. Soc. A*, **228**, 238–51 (*Feb.* 22, 1955).

The radiation from the radio star in Taurus was recorded on a radio interferometer on occasions when the radiation passed through the outer regions of the solar corona. The recorded intensity was found to decrease rapidly as the radial distance decreased. A series of observations carried out during June 1953 with interferometers of different wavelength and spacing have indicated that the results cannot be explained in terms of absorption, or large-scale refraction effects in the corona. The observations may, however, be accounted for by a scattering mechanism arising from the presence of irregular variations of electron density in the corona. An estimate of the size and electron density of the coronal irregularities is made in the range of distance 5 to 15 $R_\odot$. It is suggested that the irregular structure represents an extension of the visible coronal rays. A.

523.78

2378. Observation of the total eclipse of the sun of 30 June, 1954 at Hagaby (Sweden) and the partial eclipse with the radiotelescope of the Observatory of Meudon. M. LAFFINEUR, B. VAUQUOIS, P. COUPIAC AND W. N. CHRISTIANSEN. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1589–90 (*Dec.*, 8, 1954) In French.

A 6 m paraboloid of focal length 3·60 m was used on an equatorial mounting. The solar intensity was compared at 5-minute intervals with an area of the sky observed by turning the paraboloid through 12·5° about the polar axis. The curve on 545 Mc/s showed fewer fluctuations than in the 1952 eclipse, indicating the presence of fewer coronal-active regions. The residual intensity at the moment of totality was 11%, compared with 19·5% for the 1952 eclipse.

M. W. OVENDEN

523.842

2379. A study of the Roche model. Z. KOPAL. *Jodrell Bank Ann.*, **1**, *No.* 3, 37–57 (*June*, 1954).

A mathematical treatment of close-binary stellar systems in which the Roche theory of equipotential surfaces (1873) is used as a basis for the quantitative study of binaries whose components may be so close as to develop an actual point of contact. For the limiting case, it is shown that, for two centrally-condensed components in contact, the Roche figure will assume a dumb-bell shaped envelope, the two branches meeting in a single point on the x-axis corresponding to zero gravity. For such a model it is deduced that, for values of the orbital inclination $< 34·4$ degrees, no binary system can exhibit eclipses even when its components are sufficiently close to be in physical contact. Application of the model to observed binary systems is deferred to a later paper.

D. R. BARBER

523.852.21

2380. Photometry and polarization of some diffuse nebulae. I. M.-T. MARTEL. *J. Phys. Radium*, **15**, *No.* 12, 81 S–82 S (*Dec.*, 1954) In French.

Practical details are given of a photographic method for obtaining, at different points within the nebula, brightness and degree of polarization in both photographic and photovisual wavelengths, using two different types of polarizing filters due to Öhman (1939), and Lyot (1949) respectively. The aim of the investigation has been to elucidate problems relating to the existence in the nebular regions of discrete clouds of solid scattering particles: the position of the exciting star within these scattering regions; and the nature of the particles involved. Results are tabulated for objects, NGC 7023, IC 4601a and b, BD-19 4357, IC 1287, NGC 6589 and IC 1284.

D. R. BARBER

523.852.22 : 523.872

2381. Electron densities in planetary nebulae. M. J. SEATON. *C.R. Acad. Sci.* [*Paris*] **237**, *No.* 23, 1592–4 (*Dec.* 8, 1954) In French.

Electron densities obtained from the relative intensities of forbidden lines in the spectra of planetaries are compared with those obtained from surface luminosities by Liller and Aller (1954), after correction for interstellar absorption. The results are in good agreement if the nebulae are taken to be at a distance of 4300 parsecs. D. R. BARBER

523.852.3

2382. Remarks on the determination of the masses of extra-galactic nebulae. I. On the applicability of the virial theorem to the determination of the mass of extra-galactic nebular clusters. T. SCHMIDT. *Ann. Astrophys.*, **17**, *No.* 4, 275–86 (1954) In French.

The virial theorem is set up in the form $2T + \Omega = \frac{1}{2}\frac{d^2}{dt^2}I - \frac{1}{2}\frac{d}{dt}\Sigma\dot{m}_i r^2{}_i$ and the errors involved in using the approx. $2T + \Omega = 0$ in estimating the mass of a cluster are discussed. The non-stationary terms are averaged over the time of relaxation for the cluster

and estimates are made of contributions arising from nebular encounters and escapes. It is concluded that the errors involved in mass determinations amount to only a few per cent. R. A. NEWING

523.872

2383. Study of the interstellar band at 4430 Å in some Wolf–Rayet stars. Y. ANDRILLAT. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 23, 1590–2 (*Dec.* 8, 1954) In French.

A note describing the location of the presence of the 4430 Å band in microphotometer registrations of stars in Cygnus. The central intensity varies with the particular star and also appears to be a function of the distance. Values are given of the measured central intensity and the distances derived in a previous note. Attention is drawn to a star in Cepheus where the band is extremely strong. Comparisons with another worker confirm the research. Difficulties due to nearby emission in certain types are pointed out. E. G. MARTIN

523.877

2384. On the problem of softening of radiation by multiple Compton scattering in stellar atmospheres containing free electrons. K. K. SEN. *Proc. Nat. Inst. Sci. India,* **20,** *No.* 5, 530–41 (*Sept.–Oct.,* 1954).

The problem of softening of radiation by multiple Compton scattering in stellar atmospheres containing free electrons, has been solved in the first approximation (in Chandrasekhar's method of solution by Gaussian approximation) by the method of trigonometrical series. The intensity distribution at the outer surface has been calculated by retaining the first- and the second-order terms of Taylor's expansion of scattered intensity. The first-order calculation by the method of trigonometrical series gives a result which is identical with that found by Chandrasekhar's method with the aid of Green's function. The second-order calculation considerably reduces the error which was noticed by Chandrasekhar in the first-order calculation. A.

523.877

2385. Remarks on the evolution of stars. IV. On the evolutionary track of cluster stars. V. On the formation of stellar systems. VI. Notes on the Pleiades. E. SCHATZMAN. *Ann. Astrophys.,* **17,** *No.* 5, 377–81, 382–97, 398 (*Sept.–Oct.,* 1954) In French.

For Pt III, see Abstr. 1481 (1955). The H–R diagram for stars of a cluster is discussed and the upward bend of the upper main sequence is explained by the fact that some stars of the cluster have not completed their contraction. The energy of a system formed by the contraction of a turbulent medium into rotating stars is shown to be necessarily negative and the rate of escape of stars from the resulting non-stationary cluster is discussed. Support for the theory is claimed from the observed proper motions of the brighter stars of the Pleiades which show them to form a contracting system. R. A. NEWING

523.877

2386. On the existence of hydrogen atmospheres in red giant stars. U. R. BURMAN. *Proc. Nat. Inst. Sci. India,* **20,** *No.* 5, 620–33 (*Sept.–Oct.,* 1954).

Attempts to answer the question whether a three-phase configuration consisting of a central convective core, an intermediate radiative zone (having the same chemical composition as that of the core) and an outer envelope of pure hydrogen also in radiative equilibrium, can serve as a suitable model for a red giant star, whose mass, radius and luminosity are known from observations. An opacity formula appropriate to highly ionized hydrogen has been used for the outer envelope, while the usual Kramers' law of opacity has been assumed for the intermediate region. The central temperatures for the computed models satisfying all these conditions are found to be extremely low (about 2–3 million degrees), so as to be totally inadequate to account for the high luminosities of these stars by any of the known mechanisms of thermonuclear reactions. A two-phase configuration consisting of a central convective core surrounded by a radiative hydrogen envelope has also been considered in this connection. It is found that here also the equations furnish no physically admissible solutions. It is, however, known that three-phase configurations can be built up with central temperatures appropriate for thermonuclear energy generation, when Kramers' law of opacity is assumed to hold throughout the model outside the central convective core. The different behaviour obtained in the present case is clearly to be attributed to the opacity governing the structure of the hydrogen envelope. It is thus reasonable to conclude that under the conditions envisaged here an atmosphere of pure hydrogen is not compatible with the structure of a red giant star. A.

523.877 : 539.172

Technetium–neutrino cycle in certain stars. *See Abstr.* 3084

PHYSICS 53

53

2387. Concept and theoretical significance of physical quantities. H. NIEHRS. *Naturwissenschaften,* **41,** *No.* 20, 461–5 (1954) In German.

Using temperature and quantity of heat as particular examples the dependence of the definitions of the concepts of fundamental physical quantities on such basic operations as bringing bodies into contact, or, in the electrical case, connecting them electrically, is considered. It is shown that quantities may be combined if the operations on which they depend have formal properties similar to those of mathematical operations and that different kinds of quantities which are equivalent, for example, gravitational and inertial mass, depend on the formal equivalence of the properties. S. WEINTROUB

53.081.1 : 621.3.081.1

2388. MKS units in electricity and magnetism. T. P. MERRITT. *Amer. J. Phys.,* **23,** *No.* 2, 79–81 (*Feb.,* 1955).

The need for a strict definition of fundamental units

of measurement is pointed out. The fact that the ampere is defined by an equation in terms of other previously defined quantities requires that it be defined in terms of those quantities. This would give the ampere the unit of newton$^{\frac{1}{2}}$, and would make the permeability unitless. The instructional value of this analysis is pointed out by showing the ease with which the undergraduate student may balance, dimensionally, equations involving electrical quantities. A.

FUNDAMENTALS 530.1

530.12

2389. On the choice of the field equations of projective relativity theory. K. JUST. *Z. Phys.*, **139**, *No.* 5, 498–503 (1954) In German.

Field equations have been derived from a variation principle with a Lagrange function of the form $J^{\alpha}(R - \lambda J^{-2}J_{\nu}J^{\nu})$ where α, λ are constants, R is the 5-dimensional curvature scalar and $\frac{1}{2}J$ is the gravitational constant which is here treated as a field variable. The choices made by Jordan and others for α and λ are discussed and attention is drawn to the advantages of replacing previous values by $\alpha = -\frac{1}{2}$, $\lambda < \frac{1}{2}$. The case $\lambda = 0$ is examined.

R. A. NEWING

530.12

2390. The motion of the energy centre of gravity and the energy momentum tensor of electromagnetic fields in dielectrics. G. GYÖRGYI. *Acta phys. Hungar.*, **4**, *No.* 2, 121–31 (1954) In German.

The author shows that both the Abraham and the Minkowski energy momentum tensors are consistent with the usual concepts of mechanics, but Minkowski's assumptions are considered to be artificial.

J. H. MASON

530.12

2391. A theory of the gravitational field with a single field-function. A. PAPAPETROU. *Z. Phys.*, **139**, *No.* 5, 518–32 (1954) In German.

A recently developed theory [*Mathematische Nachrichten*, **12**, 129, 143 (1954)] based on the line element $ds^2 = e^{\gamma}dt^2 - e^{\phi}(dx^2 + dy^2 + dz^2)$ is here modified by the assumption $\chi = \chi(\phi)$ and the special case $\chi = -\phi$ is considered in detail. The theory requires that the metric form be invariant under coordinate transformations, and permissible transformations are therefore restricted to rotations in 3-space and the linear transformations $x_i' = \alpha x_i$, $x_0' = \alpha^{-1}x_0$. The field equations reduce to the single equation $2\mathfrak{R}_0^0 = \kappa(\mathfrak{T}_0^0 - \mathfrak{T}_i^i)$ and the dynamical equation $\mathfrak{T}_{\mu;\nu}^{\nu} = 0$ to $\mathfrak{T}_{\mu,\nu}^{\nu} = -\frac{1}{2}\phi_{,\mu}(\mathfrak{T}_0^0 - \mathfrak{T}_i^i)$. A consideration of the static spherically symmetric solution shows that the three observational tests would not distinguish between the present theory and Einstein's general theory. R. A. NEWING

530.12

2392. Remarks on Thiry's unified [field] theory. F. HENNEQUIN. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1582–3 (*Dec.* 8, 1954) In French.

"Isothermal" coordinates in 5-space are introduced such that $\partial_{\alpha}(\gamma^{\alpha\lambda}\sqrt{\gamma}) = 0$. In the associated 4-space, the equation for $\lambda = 0$ is interpreted as a gauge fixing condition for the electromagnetic potentials. A definition of mass in Thiry's five-dimensional theory is given which reduces to that of general relativity in a special case. R. A. NEWING

530.12

2393. Non-static spherically symmetric solution of the equations of Einstein's unified theory. S. MAVRIDÈS. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1597–9 (*Dec.* 8, 1954) In French.

Tonnelat's results are used to show that $R_{\mu\nu}$ will reduce to the static form unless $g_{23} \neq 0$.

R. A. NEWING

530.12

2394. The general solution of Einstein's equations $g_{\mu\nu;\rho}^{+-} = 0$. M.-A. TONNELAT. *J. Phys. Radium*, **16**, *No.* 1, 21–38 (*Jan.*, 1955) In French.

Previous work [Abstr. 826–8, 5065 (1951)] is represented with great mathematical detail. A special case of the general solution reproduces Bonnor's results for static spherically symmetric fields [Abstr. 2406 (1952)]. Detailed formulae are also given for non-static symmetric fields. R. A. NEWING

530.12

2395. Geons. J. A. WHEELER. *Phys. Rev.*, **97**, *No.* 2, 511–36 (*Jan.* 15, 1955).

Associated with an electromagnetic disturbance is a mass, the gravitational attraction of which under appropriate circumstances is capable of holding the disturbance together for a time long in comparison with the characteristic periods of the system. Such gravitational-electromagnetic entities, or "geons," are analysed via classical relativity theory. They furnish for the first time a completely classical, divergence-free, self-consistent picture of the Newtonian concept of body over the range of masses from $\sim 10^{39}$ g to $\sim 10^{57}$ g. Smaller geons are quantum objects whose analysis would call for the treatment of characteristic new effects. Topics covered in the discussion include: 1. Need for a self-consistent formulation of the concept of "body" in classical physics; geons *v.* free waves; electrical neutrality of geon; size and mass relations; the quantum limit and electron pair phenomena. 2. Orders of magnitude for toroidal geons; first estimates of leakage rates; a "phosphor" model of a geon; attrition and attritivity; energy action relation. 3. Idealized spherical geon; conditions required for symmetry; instability relative to pairing of light rays; time scale of instability long compared to vibration periods; spherical metric; wave equation for electromagnetic potential; evaluation of stress-energy tensor; its position as source of gravitation field; the gravitational field equations; the three equations of the self-consistent geon; simplification by scale transformation; first analysis of the eigenvalue problem; further scale transformation to get behaviour of solution in active region of geon; further analysis of eigenvalue dependence; electronic calculator integration of equations of self-consistent geon; mass and radius values. 4. Transformations and interactions of electromagnetic geons; evaluation of refractive index barrier penetration integral for spherical geon; photon-photon collision processes as additional mechanism for escape of

energy from system; restatement in language of coupling of characteristic modes; the thermal geon; comparison of gravitation and virtual electron pair phenomena as sources of coupling between modes; gravitational coupling and collective vibrations of geon; fission of a geon; interaction between two geons simple at large distances; orientation dependence and exponential term at intermediate distances; violent transmutation processes in closer encounters. 5. Influence of virtual pairs on geon structure; description in terms of refractive index correction; relation to photon-photon collision picture; more precise formulation via Heisenberg–Euler electrodynamics; corrections to stress-energy tensor and electromagnetic field equations. 6. Neutrino-containing geons; general similarity to electromagnetic geons; specificity of geon-geon interactions; the size subject to simple analysis unexpectedly limited by neutrino-neutrino encounters and the process $\nu + \nu \rightarrow \mu + e$; similarity of size limitation to that for electromagnetic geons; comments on present status of neutrino theory of light. 7. Electricity, Gauss's theorem, and gravitational field fluctuations. 8. Conclusions: the geon completes the scheme of classical physics; one's interest in following geons into quantum domain will depend upon one's view of the relation between very small geons and elementary particles. A.

530.145

2396. The quantum theory of radiation. W. HEITLER. 3rd Ed. *London: The Oxford University Press* (1954) xiii + 430 *pp*. Review in *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 128 (*Feb.*, 1955).

"The length of this new edition has been increased considerably . . . and this work is indispensable both for those workers whose main interest lies in the formal development of the theory as well as those interested chiefly in the application of the theory to concrete problems of the interaction of high energy radiation with matter."

530.145

2397. Angular momentum in non-spherical fields. A. DE SHALIT. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 359–63 (*March*, 1954; publ. *June*, 1954).

The angular momentum J^p of a particle in a field not possessing spherical symmetry is not a good quantum number. A "field angular momentum" J^f is defined which has the requisite properties of angular momentum. It is shown that $(J^p + J^f)$ commutes with the interaction part of the Hamiltonian of the system, $V(r)$. Provided $V(r)$ can be expanded in spherical harmonics such that the expansion coefficients are the generalized coordinates of the free field, J^f can be constructed. The expression obtained for J^f is identical with that calculated by Bohr [Abstr. 4524 (1952)] for the liquid drop model. G. FIELD

530.145

2398. Angular momentum of a real field. R. H. DICKE. *Phys. Rev.*, **97**, *No.* 2, 536–9 (*Jan.* 15, 1955).

It is paradoxical that a field oscillating in a mode which on grounds of symmetry contains no angular momentum should carry angular momentum when quantized. This angular momentum is shown to result from zero-point oscillations in other modes. The operator for the square of the angular momentum of the field is discussed. A.

530.145

2399. On the functional representation of corpuscles. F. AESCHLIMANN. *J. Phys. Radium*, **15**, *No.* 11, 752–6 (*Nov.*, 1954) In French.

The complex space-time function u representing a particle [Abstr. 5289 (1953)] is used to define a fluid of density $|u|$ in a state of irrotational motion defined by the velocity potential $-(h/m)\arg u$. Classical equations of motion are assumed, but the equation of continuity is not necessarily satisfied. A nonlinear equation is derived for u, the linear part of which is identified with equations arising in de Broglie's theory of the double solution. R. A. NEWING

530.145

2400. On the contribution of the electrostatic field to mass quantization. E. MINARDI. Letter in *Nuovo Cimento*, **12**, *No.* 6, 950–1 (*Dec.*, 1954) In Italian.

The result of a previous paper [Abstr. 8031 (1954)] is extended to include the effect of an electrostatic field. If m_0 is the mass of a neutral particle, as determined previously, the modified mass is $m_0 + U$, where U is the mutual electrostatic energy, calculated from the charge distribution. L. S. GODDARD

530.145

2401. A proposed notation for quantized angular momenta. J. A. SPIERS. Letter in *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 1, 50–1 (*Jan.*, 1955).

530.145

2402. Application to the theory of quantized fields of an exact solution to certain linear operator equations. A. VISCONTI. *J. Phys. Radium*, **16**, *No.* 1, 1–15 (*Jan.*); Erratum, *No.* 2, 124 (*Feb.*, 1955) In French.

After reviewing certain properties of linear equations in Hilbert space, a new method of exact solution is developed. This solution involves a rearrangement of the terms of the usual perturbation series. It is summable in the sense defined by Nörland, and avoids the calculation of the traces required by the Fredholm method. The application of the method to the S-matrix shows that some simple examples, where the discussion can be carried through, do not even have a solution summable in the above sense. P. T. MATTHEWS

530.145

2403. Effect of e.m. radiation on the self-energy of free-electrons. I. I. SINGH. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 557–62 (*Sept.–Oct.*, 1954).

The change in self-energy of an electron due to the presence of an electromagnetic field is investigated. It is shown that this contribution is finite and comes out the same on Dirac's one-electron theory (all negative energy states empty) and on "hole" theory (all negative states occupied). A.

530.145

2404. Gauge invariance and renormalization in electrodynamics. D. RIVIER. *Phys. Rev.*, **97**, *No.* 2, 505–6 (*Jan.* 15, 1955).

A one-parameter infinitesimal group of gauge transformations for the electromagnetic potential has been defined. On defining the electromagnetic potential by a limiting process from a vector field described by two real components, it is possible to set up a Lagrangian which is invariant under

infinitesimal gauge and Lorentz transformations and leads to equations of motions which now include the "supplementary conditions." The constants of motion are gauge-dependent and changes in these constants upon gauge transformation may be regarded as a "renormalization." A.

530.145

2405. Renormalization of a covariant approximation scheme in field theory. R. ARNOWITT AND S. GASIOROWICZ. *Phys. Rev.*, **97**, *No.* 3, 823–30 (*Feb.* 1, 1955).

An approximation scheme for the one-nucleon Green's functions previously put forward by the authors is renormalized. The experimental mass and the constants Z_1 and Z_2 are rigorously expressed as free-particle limits of integrals over the kernels appearing in the scheme. The mass and wave-function renormalization are carried out rigorously; the vertex renormalization is performed by a slight redefinition of the approximation scheme, without greatly altering the physical assumptions peculiar to each approximation. General prescriptions for renormalization are written down, and the first three approximations are explicitly shown to be finite. A.

530.145

2406. On the interaction of an electron with the fluctuations of the electromagnetic field in a vacuum. N. S. KALITSIN. *Zh. éksper. teor. Fiz.*, **25**, *No.* 4(10) 407–9 (1953) In Russian.

In the manner of the papers of Welton [Abstr. 666 (1949)] and Weisskopf [Abstr. 5412 (1949)] the equation of motion of a non-relativistic, classical electron (but with the radiative damping term $(2e^2/3c^3)\ddot{x}$ retained) subject to a periodic force is solved. The resulting root mean square amplitude due to the vacuum fluctuations is essentially the same as in Weisskopf when the same cut-off is used [$(mc^2/\hbar\nu)^2$ for $\hbar\nu > 2mc^2$], but the mean kinetic energy of the fluctuations is finite ($\sim 3\cdot 14\times 10^{-3}mc^2$). W. J. SWIATECKI

530.145

2407. Antiproton production. G. FELDMAN. Letter in *Phys. Rev.*, **95**, *No.* 6, 1697 (*Sept.* 15, 1954).

The threshold for proton pair production is lowered to 4·1 BeV if the pair is produced in a two-step process $p + N \rightarrow N + N + \pi$; $\pi + N \rightarrow N + p + \bar{p}$, where $\bar{p}$ is the antiproton. G. E. BROWN

530.145

2408. On the theory of excited states of nucleons. I. V. YA. FAĬNBERG. *Zh. éksper. teor. Fiz.*, **25**, *No.* 6(12) 636–43 (1953) In Russian.

The uniqueness of the equations for a particle with 2 spins ($\frac{1}{2}$ and $\frac{3}{2}$) is discussed. It is shown that the equations for such particles studied by H. Bhabha [Abstr. 1445 (1952)] and V. L. Ginzburg, [*Zh. éksper. teor. Fiz.*, **13**, 93 (1943)], are in fact equivalent. This is studied in more detail by writing the equations in a spin-tensor formalism analogous to that of Ginzburg [*ibid.*, **12**, 425 (1942)]. W. J. SWIATECKI

530.145

2409. On the theory of excited states of nucleons. II. V. YA. FAĬNBERG. *Zh. éksper. teor. Fiz.*, **25**, *No.* 6(12) 644–52 (1953) In Russian.

The aim of this work is the development of a perturbation treatment for the solution of equations with higher spins in the presence of interactions. The nature of the difficulties associated with the introduction of interactions in such equations is discussed; at the root is the fact that in the case of higher spins the number of components of ψ exceeds the number of linearly independent solutions, necessitating the introduction of auxiliary conditions. The method of Feynman [Abstr. 243, 2187 (1950)] is extended to particles with higher spin. [See also A. D. Galanin, Abstr. 9269 (1951), 7959–60 (1952)]. A method for the construction of the S-matrix for such particles is deduced in the case when the interaction Hamiltonian is not given. The expression for the inverse operator of the equations for a particle whose spin can be $\frac{1}{2}$ or $\frac{3}{2}$ is deduced in the spin-tensor formalism (see Pt I). The relation is given between the interaction constants of such a particle interacting with ps. scalar mesons in the case of ps. vector coupling. Out of the 6 interaction invariants, only 4 are independent. W. J. SWIATECKI

530.145

2410. On a clear ['anschaulich'] representation of the state of a particle with spin $\frac{1}{2}$ in non-relativistic quantum mechanics. G. A. ZAĬTSEV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 6(12) 653–66 (1953) In Russian.

It is shown that, instead of giving the components of a spinor as functions of position and time in order to characterize the state of a spin-$\frac{1}{2}$ particle, one can specify a field of triads of mutually orthogonal vectors **a**, **b**, **c** of equal lengths, the 4 components of the spinor appearing as parameters in the orientations and lengths of the triads. The graphical representation of spinors by triads of vectors is illustrated in simple cases, e.g. the time factor $\exp(-iEt/\hbar)$ in the Schrödinger equation corresponds to a rotation of all triads around **c** with the same frequency $2E/\hbar$. The view is expressed that the triads of vectors may have a more immediate physical significance than the corresponding spinor components. The above equivalence of spinors and vector-triads shows that the former could be used in the kinematics of rigid bodies. See abstract following. W. J. SWIATECKI

530.145

2411. Real spinors in the four-dimensional Minkowski space. G. A. ZAĬTSEV. *Zh. éksper. teor. Fiz.*, **25**, *No.* 6(12) 667–74 (1953) In Russian.

The theory developed in the preceding abstract is generalized to the case of the 4-dimensional transformations of relativity. In analogy with the 3-dimensional case, real spinors are discussed whose components can be regarded as parameters specifying the elements of a 4-dimensional vector and an antisymmetric 4-dimensional tensor of 2nd rank, characterized by the vanishing of its two invariants. The first paragraph deals with the definition and a formal analysis of the transformation properties of certain tensor matrices, which are then applied to the study of real spinors in 4 dimensions. The notation of electromagnetism is used for the antisymmetric tensor (**H**, **E**) and the 4-dimensional vector (**j**). The triad of orthogonal vectors discussed in the preceding abstract is then essentially equivalent to **E**, **H**, **j** and the vanishing of the invariants takes the form $\mathbf{E}^2 - \mathbf{H}^2 = 0$, $\mathbf{E} \cdot \mathbf{H} = 0$. W. J. SWIATECKI

530.145

2412. The irreducible representations of the Lie-algebra of the orthogonal group with spin $\frac{3}{2}$. K. VENKATACHALIENGAR AND K. N. SRINIVASA RAO. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 509–23 (*Sept.–Oct.*, 1954).

The matrices of all the finite-dimensional representations of the Lie-algebra of the orthogonal group with any number of symbols with spin $\frac{3}{2}$ are explicitly determined. For this purpose the direct product resolution of such an algebra into that of a Dirac algebra and a ξ-algebra due to Madhava Rao and others are used. The matrices for the representations of the ξ-algebra are found first; since those of the Dirac-algebra are known one can work out the same for the Lie-algebra. Finally the centre of the ξ-algebra is determined. A.

530.145

2413. Spinor identities. R. SHAW. Note in *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 1, 234–6 (*Jan.*, 1955).

Identities involving four (anticommuting) spinor fields are constructed. In particular the expression for the Wigner–Critchfield [*Phys. Rev.*, **63**, 417–25 (1943)] interaction in terms of the usual invariants of β-decay is derived for a general representation of Dirac matrices. G. FIELD

530.145

2414. Biquadratic spinor identities. K. M. CASE. *Phys. Rev.*, **97**, *No.* 3, 810–23 (*Feb.* 1, 1955).

The representation-independent biquadratic identities which Pauli has proved to hold between a Dirac wave-function and its adjoint are shown to be generalizable in several ways. To obtain these generalizations it is first shown how the symmetrical Kronecker product of two spinor representations of the orthogonal group in n dimensions decomposes. Then a method is given to express the tensors formed in a particular way from two covariant and two contravariant spinors in terms of those formed in any other way. These results are applied to write explicitly all biquadratic scalar and pseudoscalar identities in 2ν dimensions and all scalar identities in $2\nu + 1$ dimensions. The way to obtain more general tensor identities is indicated. A.

530.145

2415. The nucleon Green function in charged meson theory. S. F. EDWARDS. *Proc. Roy. Soc. A*, **228**, 411–24 (*March* 8, 1955).

The method of functional integration [Abstr. 6281 (1954)] is used on the problem of obtaining the nucleon Green function including radiative corrections in charged scalar meson theory without nuclear recoil. An explicit functional integral for the solution in the presence of an external field is given, and since this cannot be evaluated explicitly a general method is proposed for an approximate evaluation. The method is illustrated by solutions for weak and strong coupling, and the structure of these solutions is discussed. A.

530.145

2416. Anomalous magnetic moments of nucleons. III. F. E. PRIETO C. *Rev. Mexicana Fís.*, **1**, *No.* 3, 165–81 (*Oct.*, 1952) In Spanish.

For Pt II, see Abstr. 4609 (1953). The polarization part of the second-order correction to the current operator is calculated, and the corrections to the magnetic moments of nucleons are obtained. It is found that only the symmetrical theory gives corrections to both the proton and the neutron moments. Adjusting the coupling constant to obtain the experimental value of the neutron moment, a value is obtained for the proton moment which is about 60 times smaller than the experimental one. The introduction of the electromagnetic correction does not improve these results because it is too small compared with the mesic correction. A.

530.145

2417. Scattering of photons by an external field. F. E. PRIETO C. *Rev. Mexicana Fís.*, **1**, *No.* 3, 182–91 (*Oct.*, 1952) In Spanish.

The computation methods of Feynman and Dyson are used to obtain the cross-section for the scattering of photons in any given external field. A.

530.145

2418. Multi-level scattering in Fock space. I. F. M. MEDINA NICOLAU. *Rev. Mexicana Fís.*, **2**, *No.* 2, 117–36 (*April*, 1953) In Spanish.

The time-dependent description of the many-level scattering is discussed. The interaction is assumed to take place through the formation of a compound nucleus, and the description is given in an appropriate Fock space. The Hamiltonian of the problem is derived, and the quantum mechanical representation of the potential obtained, this potential having no classical analogue. A.

530.145

2419. Multi-level scattering in Fock space. II. F. M. MEDINA NICOLAU. *Rev. Mexicana Fís.*, **2**, *No.* 4, 268–304 (*Oct.*, 1953) In Spanish.

The time-dependent solution for the scattering and disintegration processes is discussed. The asymptotic behaviour of these time-dependent solutions, and the transient effects in the scattered current, are analysed. A.

530.145

2420. Dynamical description of scattering by a potential. J. M. LOZANO. *Rev. Mexicana Fís.*, **2**, *No.* 3, 155–79 (*July*, 1953) In Spanish.

The time-dependent description of the scattering of a wave packet by a short-range potential. It is shown that when the wave packet is initially outside the scatterer, it is possible to introduce an appropriate time-dependent Green function to describe the scattering process. This Green function is evaluated explicitly in terms of error-integral functions, and the only parameters that appear in the Green function are the poles of the S-matrix. From the asymptotic behaviour of the Green function when $t \to \infty$, restrictions on the position of the poles of the S-matrix are obtained which agree with those due to the definition of the S in terms of the derivative matrix R. The present analysis is carried out for arbitrary angular momentum. A.

530.145

2421. The connection between the R-matrix and the S-matrix. N. G. VAN KAMPEN. *Rev. Mexicana Fís.*, **2**, *No.* 4, 222–32 [In Spanish] = 233–43 [In English] (*Oct.*, 1953).

It is shown that the analytic properties that Wigner

found for the R-matrix are equivalent to the properties of the S-matrix that can be deduced from the causality condition. A.

530.145

2422. Polarization of nucleons by scattering with spin-orbit coupling. A. SJÖLANDER AND S. KÖHLER. *Ark. Fys.*, **8**, *Paper* 52, 521–5 (1954).

General expressions for the scattering amplitude and polarization of particles scattered by a potential $\propto V_0(r)+V_1(r)\mathbf{s}\,.\,\mathbf{l}$ are derived, also in the presence of a Coulomb interaction. If V_1 is small the effect of varying its strength can be studied by a simple formula. W. J. SWIATECKI

530.145

2423. On a new method for calculation of scattering phase shifts. V. RISBERG. *Arch. Math. Naturvid.*, **53**, *Paper* 1, 1–8 (1954).

It is shown that for short-range forces a variational method, similar to the Ritz method for the discrete spectrum, can be applied to the continuous spectrum, giving the phase shift as a maximum value. See also Abstr. 777–8 (1952). A.

530.145

2424. Production of antiprotons in p–p collisions. D. FOX. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 304–7 (*March*, 1954; publ. *June*, 1954).

The cross-section σ near threshold (5·6 BeV) is calculated using 4th-order Feynman diagrams. For any type of weak coupling $\sigma = K(\text{energy/proton mass})^{9/2}(\text{coupling strength})^4$. For the case of ps. scalar meson theory with ps. vector coupling K is found to be $1{\cdot}2\times10^{-25}\,\text{cm}^2$. W. J. SWIATECKI

530.145

2425. The generalised interaction potential between nucleons. K. C. KAR AND H. MUKHERJEE. *Indian J. theor. Phys.*, **2**, *No.* 1, 17–24 (*June*, 1954).

Introducing the concept of nucleonic magnetic moment and corresponding magnetic field, a generalized formula has been derived for the short-range interaction potential between two nucleons by taking into account the spin-spin and spin-orbit effects. The effect of the spin of the emitted meson on the interaction potential is also discussed. It is shown that the idea of a short-range static potential leads to the pseudovector potential derived by Kemmer. A.

530.145

2426. Pseudoscalar meson theory and intermediate coupling. M. JEAN. Letter in *J. Phys. Radium*, **15**, *No.* 10, 694–6 (*Oct.*, 1954) In French.

Using a generalization of Tomonaga's method [Abstr. 2981 (1949)] to include virtual mesons in s and p states surrounding a bare nucleon the expectation value of the number of mesons and the energy are worked out as functions of the coupling strength $G^2/4\pi$. Even for $G^2/4\pi \sim 10$ only two mesons play a significant role. W. J. SWIATECKI

530.145

2427. Tensor forces depending on the velocity. M. MOSHINSKY. *J. Phys. Radium*, **15**, *No.* 11, 725–32 (*Nov.*, 1954) In French.

Invariance with respect to space and time reflections and space rotation restricts the possible forms of such interactions. Some of the simpler types which, in addition, are not more than quadratic in the relative momentum are investigated in more detail. The equations of motion are identical with those of the theory of elasticity. The resulting wave equation is solved using vector spherical harmonics. The expression for the particle flux is derived and the boundary conditions at a surface of discontinuity are deduced. W. J. SWIATECKI

530.145

2428. Conservation of fermion charge. G. MARX. Note in *Z. Naturforsch.*, **9a**, *No.* 12, 1051–2 (*Dec.*, 1954) In German.

A new conservation law is stipulated, that of the conservation of "fermion charge," f, which is to be $(+f)$ for ordinary Fermi particles and $(-f)$ for antiparticles. The numerical value of f is to be obtainable from a knowledge of the Fermi coupling strength for β-decay and other processes. The conservation law would exclude those decay processes which have hitherto been theoretically admissible, but have not been observed. It is compatible with the form of the universal Fermi interaction Hamiltonian put forward by Konopinski and Mahmoud [Abstr. 1057 (1954)]. G. FIELD

530.145

2429. The relation between zero-energy scattering phase-shifts, the Pauli exclusion principle and the number of composite bound states. P. SWAN. *Proc. Roy. Soc. A*, **228**, 10–33 (*Feb.* 15, 1955).

It is shown that for the interaction of systems described by integro-differential equations, such as the scattering of electrons by atoms or of nucleons by deuterons, tritons and other nuclei, that the zero-energy scattering phase-shift is $(n+m)\pi$, where n is the number of composite bound states of the impacted and incident particles, and m is the number of states from which the incident particle is excluded by the Pauli principle. Each of these excluded states corresponds to a solution of the integro-differential equation asymptotic to $e^{-\gamma r}$ for which the complete wave-function vanishes identically, and which therefore does not represent a bound state. It is possible to predict the zero-energy phase-shift without calculation by a knowledge of the composite bound states and of the distribution and quantum numbers of the elementary particles contained in the impacted and incident systems. A.

530.145

2430. Diffraction in time and the Dirac equation. M. MOSHINSKY. *Rev. Mexicana Fis.*, **1**, *No.* 3, 151–64 (*Oct.*, 1952) In Spanish.

Analyses the transient phenomena that appear when one opens a shutter for a beam of Dirac particles [see Abstr. 632 (1953)]. The purpose of the analysis is to establish the time-dependent spinors which will be suitable for a dynamical description of the scattering of Dirac particles, following a procedure for spinless particles that was given elsewhere. The transient Dirac spinors are expressed in terms of Lommel functions of two variables and their asymptotic properties on the light cone and when

$t \to \infty$ are discussed. The behaviour of the transient spinors under Lorentz transformations is analysed. See also abstracts following. A.

530.145

2431. Diffraction in time. O. COSTA DE BEAUREGARD. *Rev. Mexicana Fis.*, **3**, *No.* 4, 185–200 [In Spanish] = 201–16 [In English] (*Oct.*, 1954).

See preceding abstract. The author's method in this problem is essentially based on Minkowski's space-time geometry and Fresnel's intuitive treatment of diffraction. In this way, the fundamental formulae of wave-mechanics come out with a complete symmetry between space and time, and Feynman's interpretation of negative energy states is very clearly illustrated. See also abstract following. A.

530.145

2432. Diffraction in time associated with a source distribution. M. MOSHINSKY. *Rev. Mexicana Fis.*, **3**, *No.* 4, 236–52 (*Oct.*, 1954) In Spanish.

Shows that problems of diffraction in time associated with the opening and closing of a shutter, can be described in terms of a source distribution in the region occupied by the shutter. In this way, the author shows the equivalence between his approach to the problems of diffraction in time, and the one suggested in the preceding abstract. In particular, the problems of diffraction in time for relativistic particles are investigated, and an interpretation of the positive and negative energy terms that appear in the analysis is given. A.

530.145

2433. A contribution to Darwin's derivation of the magnetic moment of the electron and positron. V. S. VRKLJAN. *Period. math.-phys. astron.* [*Zagreb*] **8**, *No.* 4, 267–9 (1953) In Serbo-Croat. Summary (150 words) in German.

A representation of the Dirac α's can be found in which all elements are different from zero. The wave-functions are rearranged in this representation to exhibit the magnetic moment. G. E. BROWN

530.145

2434. Connections between the Einstein–Infeld approximation method and the perturbation method. W. KRÓLIKOWSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 8, 375–7 (1954).

It is shown that the stationary perturbation solution for the state vector Ψ of the Schrödinger equation $i\hbar(\partial\Psi/\partial t) = (H_0 + H_1)\Psi$ in the Schrödinger representation can be obtained by an application of the Einstein–Infeld approximation method [Einstein, Infeld and Hoffmann, *Annals of Mathematics*, **39**, 66 (1938)]. G. FIELD

530.145

2435. An asymptotical method for the calculation of eigenfunctions. J. I. HORVÁTH. Note in *Acta phys. Hungar.*, **4**, *No.* 2, 183–6 (1954) In German.

A critique and reformulation of a variational method of Biedenharn and Blatt [Abstr. 3131 (1954)] for the calculation of eigenfunctions. G. E. BROWN

530.145

2436. The tunnel effect and classical mechanics. E. F. BERTAUT. *J. Phys. Radium*, **15**, *No.* 10, 678–81 (*Oct.*, 1954) *In French.*

The momentum in a solution of the classical equations of motion of, e.g., a hydrogen atom can be complex. Imaginary momenta lead in quantum mechanics to penetration through a barrier.

W. J. SWIATECKI

530.145

2437. Is a new interpretation of wave mechanics possible? L. DE BROGLIE. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 1, 37–50 (*Jan.*, 1955) *In French.*

After recalling the reasons for the introduction of the "theory of the double solution" in 1927, and the difficulties confronting the causal interpretation of diffraction and eigenvalue problems, the author discusses the new interpretation which has become apparent recently. He shows how the old difficulties may be removed, and suggests possible ways of overcoming new ones. F. ANSBACHER

530.145

2438. Quantum-mechanical operators. V. ROJANSKY. *Phys. Rev.*, **97**, *No.* 2, 507 (*Jan.* 15, 1955).

The eigenvalue spectra of the Schrödinger co-ordinate operators, such as x, are continuous. Hellund and Tanaka have recently proposed to replace these operators by operators having discrete eigenvalues. In this note the question is raised whether the operators associated with the co-ordinates of a particle should have any eigenvalues at all. A.

530.145

2439. Use of causality conditions in quantum theory. M. L. GOLDBERGER. *Phys. Rev.*, **97**, *No.* 2, 508–10 (*Jan.* 15, 1955).

It is shown that the derivation of the Kramers–Kronig dispersion relations given by Gell-Mann, Goldberger, and Thirring may be carried out without the use of perturbation theory. It is further shown that the results are essentially independent of the form of the coupling between the electromagnetic field and the matter fields. The demonstration is facilitated by the construction of simple rigorous expressions for the commutator of two vector potential operators and for the S-matrix describing photon scattering. A.

530.145

2440. Goldstein's eigenvalue problem. H. S. GREEN. *Phys. Rev.*, **97**, *No.* 2, 540–2 (*Jan.* 15, 1955).

A mathematical error is found in Goldstein's solution of the Salpeter–Bethe equation with zero total energy and a cut-off factor. When this error is corrected, no solution remains of the eigenvalue problem. A.

530.145

2441. Coulomb functions for large charges and small velocities. L. C. BIEDENHARN, R. L. GLUCKSTERN, M. H. HULL, JR AND G. BREIT. *Phys. Rev.*, **97**, *No.* 2, 542–54 (*Jan.* 15, 1955).

Expansions in powers of $\eta^{-\frac{1}{3}}$, where η is defined in the introduction below, for the Coulomb wave-functions $F_L(\rho)$ and $G_L(\rho)$ and their derivatives are given for special values of $\rho = 2\eta$ and $\rho = \rho_L = \eta + [\eta^2 + L(L+1)]^{\frac{1}{2}}$, the classical turning points for $L = 0$ and any L, respectively. Expansions

applicable in the vicinity of the turning point are given as a series involving Bessel functions of order $\pm n/3$ with the expansion parameter $\rho_L^{-\frac{1}{3}}$. Approximations valid for large values of η are given and discussed. A.

530.145

2442. Rectangular potential well problem in quantum mechanics. P. H. PITKANEN. *Amer. J. Phys.*, **23**, *No.* 2, 111–13 (*Feb.*, 1955).

The one-dimensional rectangular potential well problem is one of the standard examples used in courses to illustrate quantum-mechanical properties. It has also been of value in the study of nuclear energy states. However, it is necessary to resort to graphical or numerical procedures at the last if one desires explicit values for the energy levels. It is the purpose of this article to point out a simpler and more perspicuous method of graphical solution than those used at the present time. A.

530.145 : 532.51

2443. A hydrodynamic model of wave mechanics. H. W. FRANKE. *Acta phys. Hungar.*, **4**, *No.* 2, 163–72 (1954) In German.

Some connections are obtained between physical quantities which occur in a deterministic hydrodynamic model of wave mechanics, and the more usual operators. The theory is based on a generalization of the classical Hamilton–Jacoby equation.

P. T. LANDSBERG

530.145 : 536.7

2444. Thermodynamic foundation of quantum mechanics. A. LANDÉ. *Naturwissenschaften*, **41**, *No.* 22, 524–5 (1954) In German.

An addendum to Abstr. 7139 (1954). The formal postulate of the continuity of certain symmetry-classes, which was required to exclude other than symmetric and anti-symmetric combinations of wave-functions (Bose or Fermi statistics), is now replaced by a deduction from the Nernst heat-theorem. The Born–Heisenberg commutation law can also be traced back to a new physical definition of canonical conjugation. T. P. BRODY

530.162

2445. Multiple points of paths of Brownian motion in the plane. A. DVORETZKY, P. ERDÖS AND S. KAKUTANI. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 364–71 (*March*, 1954; publ. *June*, 1954).

Definitions are given of a Brownian motion in the plane, of the path of such a motion, and of a multiple point of a path. It is proved that almost all paths have points of arbitrarily high multiplicity. The methods used are largely of a combinatorial nature.

L. S. GODDARD

530.162

2446. Entropy of information and the odd ball problem. P. J. KELLOG AND D. J. KELLOG. Letter in *J. appl. Phys.*, **25**, *No.* 11, 1438–9 (*Nov.*, 1954).

Considerations of the entropy of information are applied to the problem of finding the ball which is lighter or heavier than $N-1$ similar balls by a minimum number of weighings; the lower limit of this is the ratio of initial entropy: entropy per weighing ($=\ln 2N/\ln 3$). The practical procedure is to select only those alternatives which maximize the change in entropy per weighing. This is illustrated with regard to $N=3$. T. J. REY

530.162

2447. Quantum statistics of closed and open systems. F. ANSBACHER AND P. T. LANDSBERG. Letter in *Phys. Rev.*, **96**, *No.* 6, 1707–8 (*Dec.* 15, 1954)

The distribution functions for an ideal Bose–Einstein or Fermi–Dirac gas derived on the basis of the canonical ensemble agree with those obtained from the grand canonical ensemble for certain limiting cases, e.g. fixed density as volume $\to \infty$.

F. ANSBACHER

530.162

2448. Chains of quantal measures and the principle of negentropy. R. JANCEL AND T. KAHAN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 1, 54–7 (*Jan.* 3, 1955) In French.

The notion of quantal measure is introduced and applied to the principle of negative entropy due to Brillouin [Abstr. 100 (1954)]. The ideas have application in information theory. Chains of quantal measures are studied briefly and linked with Markoff chains of probability. L. S. GODDARD

GENERAL MECHANICS
MECHANICS OF SOLIDS 531

531.228

2449. Some problems of elastic plates containing circular holes. II. A. M. SENGUPTA. *Indian J. theor. Phys.*, **2**, *No.* 1, 37–46 (*June*, 1954).

The influence of stresses around a circular hole in a semi-infinite plate subjected to a couple M applied on its straight edge is discussed. For previous part see *Bull. Calcutta Math. Soc.*, **43**, 27 (1951). A.

531.383 : 534.13

2450. Steady state response of the Sperry rate Gyrotron or vibratory gyroscope. C. T. MORROW. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 56–61 (*Jan.*, 1955).

This has been developed as an instrument for measuring rate of turn. The instrument utilizes a tuning fork which undergoes a torsional vibration due to Coriolis forces when a rate of turn is applied. Thus, a familiar acoustical device is applied to the problem of control of aircraft. The absence of bearings gives it virtues of low electrical noise level, robustness and long life. A simplified analysis is made of the response of the instrument to steady rates of turn, with special emphasis on linearity considerations. A.

531.383 : 534.13

2451. Response of the Sperry rate Gyrotron to varying rates of turn. C. T. MORROW. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 62–7 (*Jan.*, 1955).

The treatment of the preceding abstract is extended to yield the amplitude and phase response of the instrument to impressed oscillation about the sensitive

axis. The results can be used in calculating the stability of a servo loop incorporating a Gyrotron as an element. A.

MECHANICAL MEASUREMENTS 531.7

531.715.2 : 535.81

2452. Cross-field error in unsymmetrical range finders. R. E. Stephens. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 146–7 (*March*, 1955).

As a result of tests made at the National Bureau of Standards on certain range finders of unsymmetrical construction it was found that the observed range depended upon the position in the field of view at which the coincidence was obtained. Examination of the components of the instruments for the source of this effect was unsuccessful. It was concluded that the effect was a consequence of the difference in distance, by way of the two windows of the range finder, from the target to the viewing telescope. The magnitude of the effect is accounted for by analysis on this assumption. A.

531.717.3 : 620.172.222 :.621.317.79

2453. Apparatus for measurement of sensitivity of electrical resistance of wires to strains. G. C. Kuczynski and P. F. Stablein. Note in *Rev. sci. Instrum.*, **25**, *No.* 12, 1222–3 (*Dec.*, 1954).

531.787

2454. An automatic pressure recorder for the study of gas phase kinetics. D. Patterson and R. C. Seymour. *J. sci. Instrum.*, **52**, *No.* 2, 50–1 (*Feb.*, 1955).

A recorder suitable for kinetic studies in gas phase reactions in a constant volume system is described. The instrument has been used up to pressures of 100 cm of mercury, and follows rise or decrease in pressure to 0·5 mm of mercury. A self-balancing servomechanism applies an external pressure equal to the pressure in the reaction system, and the magnitude of this pressure is continuously recorded on a pen-chart as a function of time. A.

MECHANICS OF FLUIDS 532

532.1

2455. The hydrostatic paradox: phases I and II. L. E. Dodd. *Amer. J. Phys.*, **23**, *No.* 2, 113–18 (*Feb.*, 1955).

The term hydrostatic paradox is likely to suggest the classical experiment of "Pascal's vases." In a demonstration with this apparatus the observer's attention is centred upon the vertical direction, specifically the common vertical depth of liquid in the different branches of the container, with their varying cross-sections and volumes. But the term properly has a broader connotation. Fully as striking is the hydrostatic paradox seen in the fact that the horizontal thrust of the water against a dam is independent of the volume of water impounded, and dependent only on its depth at the barrier. To differentiate sharply between these two aspects of hydrostatic paradox, the terms "Phase I" and "Phase II" are proffered. The two aspects are discussed. A.

532.137 : 541.183.022

2456. A rotational viscometer for surface films. S. C. Ellis, A. F. Lanham and K. G. A. Pankhurst. *J. sci. Instrum.*, 32, *No.* 2, 70–3 (*Feb.*, 1955).

The surface viscosity of monomolecular surface films (monolayers) spread on water has been measured with an instrument analogous to the coaxial cylinder (Couette) viscometer. A ring of platinum wire, coated with paraffin wax, is floated on the film-covered surface and rotated by a synchronous motor, transmission being through a torsion wire. The viscous drag imposed by the film on the rotating ring is calculated from the angular displacement between the ends of the torsion wire. Specimen results for serum albumen, showing its non-Newtonian behaviour, are given. A.

532.14 : 534.22 : 536.22 : 536.63

2457. On the relation between the dispersion of the velocity of sound, the specific heat, the density and the thermal conductivity of glycerine. A. K. Schulz. *J. Chim. phys.*, **51**, *No.* 10, 530–3 (*Oct.*, 1954) In French.

The thermal conductivity λ has been measured over a wide temperature range and an equation derived for λ in terms of velocity of sound, density and specific heat. The relation between specific thermal conductivities and temperature is given while the reasons for discrepancies between experimental and calculated values of λ for different frequency ranges is indicated. T. C. Toye

532.5 : 533.6.011.31

2458. Analog computer construction of conformal maps in fluid dynamics. N. P. Tomlinson, M. Horowitz and C. H. Reynolds. *J. appl. Phys.*, **26**, *No.* 2, 229–32 (*Feb.*, 1955).

A general-purpose electronic analogue computer has been used extensively to construct the streamlines around two-dimensional airfoil shapes immersed in an incompressible, nonrotating, nonviscious fluid. The computer generates a circular Lissajous pattern on a plotting table, and then transforms the co-ordinates of the circle into the airfoil shape by a conformal transformation. Two samples of the variety of airfoil shapes so constructed are shown. The accuracy of the process, which has been checked by a digital computer and a desk calculator, is quite satisfactory; the speed of the actual mapping process is highly advantageous to thorough exploration of a variety of airfoil shapes. A.

532.51 : 539.319

Second-order effects in elasticity and hydrodynamics. *See Abstr.* 3182

532.517

2459. The steady flow of viscous fluid past a fixed spheroidal obstacle at small Reynolds numbers. T. Aoi. *J. Phys. Soc. Japan*, **10**, *No.* 2, 119–29 (*Feb.*, 1955).

Making use of an exact solution of Oseen's equations of motion, the steady flow of an incompressible

viscous fluid past a prolate or oblate spheroid is discussed in detail, including a circular disk as a special case. The analytical exact solution of Oseen's equations are first obtained by the use of spheroidal functions, mathematical properties of which are also investigated separately in the writer's subsequent paper [Abstr. 2353 (1955)]. The drag experienced by a spheroid is then computed and the general formula for the drag is obtained. Approximate formulae for the drags on a prolate and oblate spheroid and on a circular disk are also derived and some numerical results are obtained. Discussions on the pressure drag and the frictional drag experienced by a spheroid are made and it is thus found that these two drags contribute to the total drag in a definite ratio which is independent of the Reynolds number. A.

532.52 : 532.62

2460. On the differential analyser solution of the water bells problem. G. N. LANCE AND E. C. DELAND. Letter in *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 1, 54–5 (*Jan.*, 1955).

Some further solutions are presented of the differential equation which determines the shape of a "water bell," a thin film of water produced when a vertical jet impinges on a flat or conical plate. These solutions were obtained by means of a differential analyser and extend the results previously obtained by numerical methods. [See Abstr. 1095 (1954).] A. T. PRICE

532.595

2461. Oscillation of mercury in a U-tube. Examination of experimental results. M. AUBERT-HUETZ AND J. HUETZ. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1587–9 (*Dec.* 8, 1954) In French.

A theoretical explanation of the observations in a previous paper [Abstr. 5333 (1954)]. T. C. TOYE

532.595 : 591.112.3

2462. Oscillatory motion of a viscous liquid in a thin-walled elastic tube. I. The linear approximation for long waves. J. R. WOMERSLEY. *Phil. Mag.*, **46**, 199–221 (*Feb.*, 1955).

The problem of determining the motion of a liquid in an elastic tube when subjected to a pressure-gradient which is a periodic function of the time arises in connection with the flow of blood in the larger arteries. In this paper the solution for a thin-walled elastic tube is given, it being assumed that the effect of the inertia terms in the equations of viscous fluid motion can be neglected. An approximate correction for the effect of the inertia terms will be given in Pt II. It is shown that, when the liquid contained in the tube is viscous, the pressure-wave cannot be propagated without distortion. Not only is the motion damped, but the wave-velocity rises as the frequency increases. For constant frequency, the wave-velocity rises as the viscosity of the liquid decreases, tending to an asymptotic value equal to that for a perfect fluid given by Lamb (1898). It is also shown that the longitudinal oscillation of the walls of the tube (caused by the viscous drag on its inner surface) is important in determining the rate of flow, which may be 10% greater than that in a rigid tube under the same pressure-gradient. A.

CAPILLARITY 532.6

532.61

2463. Changes of surface properties by irradiation with α-rays. Č. JECH. *Z. phys. Chem.* [*Leipzig*] **203**, *No.* 5–6, 309–11 (*Oct.*, 1954) In German.

The contact angle between water and a polystyrene surface is progressively decreased by (prior) exposure of the surface to the α-rays from a polonium source. No such effect is observed in vacuum, from which it is concluded that the effect in air is due to the action of the ionized air at the surface. W. GOOD

532.63

2464. The movement of moisture in mortars. R. BERTRANDY, R. CAIZERGUES AND R. MÉRIGOUX. *J. Phys. Radium*, **15**, *No.* 12, 68 S–69 S (*Dec.*, 1954) In French.

The penetration of water, under pressure, through a block of cement is followed electrically by observing the change, with time, of the electric current between three pairs of copper electrodes embedded in the cement and coated with insulating varnish except at their ends. The electric current is established only for short periods in order to avoid the effects of polarization. The results are interpreted in terms of the presence in the mortars of circular capillaries of equivalent radius 260 Å, or of plane-parallel channels of depth 40 or 400 Å. J. S. G. THOMAS

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

2465. Considerations on the theory of liquids. J. WINTER. *Ann. Inst. Poincaré*, **14**, *No.* 1, 1–33 (1954) In French.

Previous ideas are reviewed and the author puts forward his view that the behaviour of liquids can best be explained by assuming the existence of molecular swarms or clusters. He emphasizes a point of very great importance, namely that the atom or molecule cannot always be regarded as the unit of flow but that this may well be a cluster. The fall of η with increasing T is neatly explained by the variation in cluster size. The application to a number of cases is very well discussed. T. C. TOYE

532.7

2466. Atomic distribution in liquid helium. C. F. A. BEAUMONT AND J. REEKIE. *Proc. Roy. Soc. A*, **228**, 363–76 (*March* 8, 1955).

The angular distribution of intensity of X-radiation scattered by liquid helium has been investigated between 4·20 and 1·27°K. Liquid-ring diffraction patterns are obtained at all temperatures, with the main maximum at an angle of about 28·5°. The intensity distribution appears almost the same for all temperatures below 3°K; slight differences only are observable at 4·20°K. Detailed analyses have been made at 2·06 and 4·20°K, and the structure factors and atomic distribution functions deduced for these two temperatures. A.

532.7 : 536.71

2467. Recent theories of the equation of state for liquids. H. BENZLER. *Z. Elektrochem.*, **58**, *No.* 7, 482–92 (1954) In German.

A review of recent theories of the liquid state. Short summaries are given of the Kirkwood, and Born and Green theories based on the radial distribution function, Mayer's theory of condensation, the Lennard-Jones–Devonshire cell model and its development, the free-volume theory of Eyring, the hole-theory of Fürth and the semi-empirical theory of Eucken and others. The validity of a law of corresponding states is discussed. T. P. BRODY

532.72

2468. Contribution to the theory of thermal diffusion in liquids. V. Kinetic theory of self-diffusion and thermal self-diffusion in water. K. F. ALEXANDER. *Z. phys. Chem.* [*Leipzig*] **203**, *No.* 5–6, 357–68 (*Oct.*, 1954) In German.

For Pt IV, see Abstr. 112 (1955). A simple model is developed for the basic place-exchange process, assumed to be an activated rotation of a single H_2O molecule. The frequency constant calculated from the self-diffusion coefficient with the aid of this model agrees well with the observed Raman frequencies. Using the theory developed in previous papers and Eucken's assumptions about the association structure of water, the kinetic heat of transfer of self-diffusion can be calculated. Its temperature coefficient agrees within order of magnitude with the value calculated indirectly from the Soret-effect of dilute solutions.

T. P. BRODY

532.72

2469. Nuclear resonance and molecular movement in fluids. E. M. PURCELL. *J. Phys. Radium*, **15**, *No.* 12, 785–90 (*Dec.*, 1954) In French.

Measurements of the spin-lattice relaxation time T_1 for protons in hexane, toluene, etc., up to pressures of 10 000 kg/cm^2 using a spin-echo method, show ηT_1 to increase with pressure, showing that the relaxation is not entirely controlled by translational viscosity, but is also related to molecular rotation which is less affected by pressure. There is also a decay term of $\exp(-t^3)$ type which arises from diffusion, and it is found that relative values of the diffusion coefficient D may be obtained and that $D\eta$ is independent of pressure as required by Stokes's law. D. H. WHIFFEN

532.72

2470. A phenomenological theory of the Soret diffusion. J. A. BIERLEIN. *J. chem. Phys.*, **23**, *No.* 1, 10–15 (*Jan.*, 1955).

The classical Soret diffusion problem is solved analytically for the case of unrestricted composition in a binary liquid system, taking account of the temperature-variation of the density of the mixture. Previous treatments have neglected the phenomenon of thermal dilatation entirely and have not developed a unique general solution which applies both to dilute and to nondilute mixtures. The rigorous solution derived in the present work is similar in form to de Groot's well-known equation for dilute mixtures, but contains additional parameters characterizing the initial composition of the system and its coefficient of thermal expansion. These parameters disappear in the asymptotic approximation for a vanishing temperature gradient, but this approximation differs from that proposed by de Groot, even for dilute solutions. The asymptotic expression has practical importance for estimating the Soret coefficient and the ordinary diffusion coefficient of a system from experimental data taken during the thermodiffusional unmixing period; some examples of its application in this connection are discussed. A.

532.72

2471. A theory of thermal diffusion in liquids. E. L. DOUGHERTY, JR AND H. G. DRICKAMER. *J. chem. Phys.*, **23**, *No.* 2, 295–309 (*Feb.*, 1955).

A theory has been developed based on Denbigh's interpretation of the "net heat of transport" which arises in the thermodynamics of irreversible processes. The thermal diffusion ratio α is expressed in terms of the energies of vaporization of the pure components, the excess energy, entropy and volume of mixing, and the concentration dependence of ΔU_e. The efficiency with which the two species pack together is also introduced. The Hildebrand–Scatchard solution theory is applied to these results and α is expressed in terms of solubility parameters, molal volumes and packing efficiencies. The equations are compared with previously published experimental results, and reasonably explainable packing efficiencies are obtained. In the appendices the effects of nonrandomness of mixing are considered and the theory is extended to ternary mixtures. A.

532.72 : 539.152.2 : 539.89

2472. Nuclear magnetic resonance in liquids under high pressure. G. B. BENEDEK AND E. M. PURCELL. *J. chem. Phys.*, **22**, *No.* 12, 2003–12 (*Dec.*, 1954).

The work reported here is an application of free precession or "spin echo" techniques in nuclear magnetic resonance to a study of the properties of liquids under high pressure. The proton relaxation time T_1 was measured as a function of pressure, over the range 1 to 10 000 atmospheres, for six liquids: water, *n*-pentane, *n*-hexane, toluene, ethyl iodide, and methyl iodide. In addition to the relaxation time, the normalized values $D(P)/D(1)$ of the self-diffusion constant were measured as a function of pressure for water and methyl iodide. In each liquid T_1 decreases with increasing pressure. However, comparison of the observed variation of T_1 with pressure with Bridgman's data on the variation of viscosity η with pressure shows in all cases (except that of methyl iodide for which no viscosity data are available) that T_1 is not simply proportional to $1/\eta$, but instead $T_1\eta$ increases with pressure. Similarly, for water and methyl iodide, the diffusion constant D varies in such a way that T_1/D increases with pressure. For water the Stokes–Einstein relation $D\eta = cT$ is obeyed within the errors of observation. The behaviour of T_1 can be understood if one assumes that the dominant relaxation mechanism involves intramolecular fields, whose correlation time is determined by the rotational freedom of the molecule, and that compression of the liquid inhibits migrational freedom more drastically than rotational freedom. The necessity of making the present measurements has led to the discovery that BeCu, a heat-treatable alloy, makes a very satisfactory

high pressure, non-magnetic bomb which might well be used for other magnetic investigations under high pressure. A.

532.72 : 541.18.043

2473. Sedimentation velocity and diffusion of a solvated substance. P. CHENG. *J. chem. Phys.*, **23**, *No.* 1, 191–5 (*Jan.*, 1955).

Based on the contention that the driving force for the motion of a species relative to the mass flow in a particular direction is the negative gradient of total potential of that species in that direction, equations for both the sedimentation velocity and the diffusion of a solvated substance are derived. They are reduced to the usual expressions for a nonsolvated substance. The partial specific volume term in the equations of sedimentation velocity is shown to have theoretical justification. The advantages of expressing the sedimentation velocity in terms of solvated species are discussed. It is also shown that for the diffusion of a solvated species the "thermodynamic factor" calculated in the usual way is always greater than the gradient of chemical potential of the solvated species, except at zero concentration, by a previously neglected term arising from solvation. The effect of solvation on diffusion coefficient and on the relation between the frictional coefficients in the sedimentation and diffusion are also discussed in the light of this theory. A.

532.73

2474. Note on the temperature variation of the configurational energy of regular solutions. P. K. KATTI AND S. M. BHAGAT. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1951–2 (*Nov.*, 1954).

An approximate treatment of the effect of temperature on w, the energy gain on mixing two components, per pair of unlike neighbours. At room temperature, the 12th power part of a Lennard-Jones potential is neglected, and the result $dw/dt = -2\alpha w$ is obtained, where α is the coefficient of cubical expansion. Comparison with experiment is claimed to give reasonable agreement. J. HAWGOOD

532.73 : 541.64 : 539.13

2475. Note on solutions of linear polyelectrolyte molecules. F. OOSAWA AND N. IMAI. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2084–5 (*Dec.*, 1954).

Approximate theoretical discussion of the extensive forces of polyelectrolyte molecules at finite concentrations, with added salts. The important part of the extensive force is the result of osmotic pressure, except at low concentrations, where Coulomb repulsion has a large effect. J. HAWGOOD

532.74

2476. The system pyridine–pyrrole and the association of pyrrole. S. N. VINOGRADOV AND R. H. LINNELL. *J. chem. Phys.*, **23**, *No.* 1, 93–7 (*Jan.*, 1955).

Pyridine and pyrrole react together to form a 1 : 1 complex as shown by infrared, heat of reaction, viscosity, refractive index and density data. The heat of formation of this complex is 3·8 kcal/mole. Pyrrole itself is associated, but, like the simple alcohols, cannot be represented by a simple equilibrium. The heat of dilution of pyrrole in CCl_4 is 1·4 k/cal/mole at infinite dilution. A.

532.77

2477. Thermodynamics of dilute solutions of macromolecules. H. G. REIK AND G. GEBERT. *Z. Elektrochem.*, **58**, *No.* 7, 458–67 (1954) In German.

Expressions are developed from which the thermodynamic functions (free enthalpy, enthalpy, and entropy of dilution, as well as the excess functions which describe the deviation of the solution from ideality) can be calculated from fewer osmotic measurements than usual, because the second virial coefficient and its temperature derivative appear in the equations, so that it is no longer necessary to make several measurements at each concentration, but only sufficient measurements at various concentrations (and temperatures) to fix the virial coefficient, etc., with the required accuracy. The results obtained with these equations agree well with the general correlations between concentrations and thermodynamic functions found by Haase and Munster [see Abstr. 9320 (1951)] in dilute solutions. R. C. MURRAY

MECHANICS OF GASES 533

533.011.6 : 536.244

2478. Heating of bodies of various shapes by gases in direct and counter current. E. M. GOL'DFARB. *Zh. tekh. Fiz.*, **24**, *No.* 6, 1012–19 (1954) In Russian.

Theoretical.

533.16

2479. The viscosity of argon at pressures up to 2000 atmospheres. A. MICHELS, A. BOTZEN AND W. SCHUURMAN. *Physica*, **20**, *No.* 12, 1141–8 (*Dec.*, 1954).

This was measured by a transpiration method at temperatures between 0°c and 75°c. The results are compared with the values calculated from the theoretical formulae of Enskog for dense gases. A.

533.2

2480. The rapid expansion of compressed gases behind a piston, the effect of molecular interaction. III. The expansion of nitrogen. A. MICHELS, S. J. JACOBS AND Z. I. SLAWSKY. *Physica*, **20**, *No.* 12, 1157–68 (*Dec.*, 1954).

For Pt II, see Abstr. 6347 (1954). The results of experiments are presented. Measurements were made to include a range of initial pressure from 700 to 2500 atm. Comparison is made between the observations and predictions based on both ideal gas and real gas behaviour for an isentropic process. The results establish within experimental accuracy that (*a*) the expansion is isentropic and (*b*) good agreement is found when real p–v–T data is used to predict the results. A.

533.21 : 536.7

2481. Compressibility isotherms of oxygen at 0°, 25° and 50°c and at pressures up to 135 atmospheres. A. MICHELS, H. W. SCHAMP AND W. DE GRAAFF. *Physica*, **20**, *No.* 12, 1209–14 (*Dec.*, 1954).

533.5

2482. Determining the sensitivity of a triode ionization vacuum gauge. R. LENK. *Slaboproudý Obzor*, **15**, *No.* 10, 474–5 (1954) In Czech.

The gauge consists of three flat parallel electrodes:

a tungsten cathode, a wire-mesh anode and a collector. It is shown that the sensitivity of the device is proportional to the anode-collector distance and to the current entering the ionization space, the formula for the sensitivity being derived for a linear anode-collector potential distribution and for the conditions of negligible ion recombination and secondary ionization. The theory is in fair agreement with measured results. R. S. SIDOROWICZ

533.5 : 621.316.71

2483. A multi-circuit control for ultra-high vacuum gauges. J. H. REYNOLDS AND J. LIPSON. Letter in *Rev. sci. Instrum.*, **25**, *No.* 10, 1029–31 (*Oct.*, 1954).

The wiring diagram and operation of a vacuum gauge control circuit is described, which incorporates all the features of a sensitive intermittent ion gauge circuit and also provides automatic grid current control and automatic filament protection.

G. WITTENBERG (R)

533.6.011

2484. The activation energy for viscous flow and Sutherland's constant. C. J. G. RAW. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1946–7 (*Nov.*, 1954).

The ratio of the former to the latter quantity is found to be ~ 4 for A, N_2, O_2, CO, CH_4, and C_2H_2. W. GOOD

533.6.011.4

2485. On a perturbation theory based on the method of characteristics. C. C. LIN. *J. Math. Phys.*, **33**, *No.* 2, 117–34 (*July*, 1954).

A perturbation theory based on the method of characteristics is applied to the discussion of two-dimensional supersonic flow and wave propagation. In perturbation theory the solution appears in the form $x = x^{(0)}(\alpha, \beta) + \varepsilon x^{(1)}(\alpha, \beta) + \ldots$ with a similar expression for y, $u = u^{(0)}(\alpha, \beta) + \varepsilon u^{(1)}(\alpha, \beta) + \ldots$ with a similar expression for v. A systematic development of this formulation for x, y, u and v is presented with emphasis on the proper choice of the parameters α and β, and is applied to discuss (1) the interaction of two simple waves, (2) reflection of a simple wave from a solid boundary or free surface, and (3) the wavelength of a supersonic jet. J. S. G. THOMAS

533.6.011.5

2486. On a refinement of the transonic approximation theory. I. IMAI. *J. Phys. Soc. Japan*, **9**, *No.* 6, 1009–20 (*Nov.–Dec.*, 1954).

A new basic equation is proposed for two-dimensional supersonic flow, and its advantage discussed. A.

533.6.011.5

2487. Analysis of turbulent density fluctuations by the shadow method. M. S. UBEROI AND L. S. G. KOVASZNAY. *J. appl. Phys.*, **26**, *No.* 1, 19–24 (*Jan.*, 1955).

Shadow pictures of turbulent flow regions give a particular kind of information about the three-dimensional density field. If homogeneity and isotropy of the fluctuation field can be assumed, the statistical properties of the picture uniquely determine the correlation function or power spectrum of the three-dimensional turbulent density field. Shadow pictures obtained in the wake of a supersonic projectile were analysed in this manner and encouraging results were obtained. In order to check the validity of the method, the density fluctuations in a heated jet were measured both by the shadow method and by the more conventional hot-wire technique. A.

533.6.011.5 : 534.222.2

2488. On the curved shock wave due to an infinite wedge placed in a supersonic uniform flow. K. HIDA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 853–60 (*Sept.–Oct.*, 1954).

It is shown with the aid of analysis in the hodograph plane that besides the well-known two-shock configurations, two more shock configurations can occur due to an infinite wedge placed in a supersonic uniform flow. These two shocks are both curved waves; one is an attached shock which turns from a weak shock at the vertex of the wedge to a strong one at infinity, while the other is a detached shock which is normal at the nose of the body and becomes strong at infinity. Numerical calculations are carried out for the case when $M_1 = 1{\cdot}50$ and $\theta_0 = 11° 45'$, where M_1 and θ_0 are respectively the Mach number at infinity upstream and the semi-vertical angle of the wedge. A.

533.6.011.5 : 534.222.2

2489. On the attached curved shock in front of an open-nosed axially symmetrical body. H. OGUCHI. *J. Phys. Soc. Japan*, **9**, *No.* 5, 861–6 (*Sept.–Oct.*, 1954).

The flow near the nose over an open-nosed axially symmetrical body placed in a uniform flow of sufficiently high Mach number is considered. The equation valid near the nose is derived by employing a method of perturbation. From the solution of this equation, the flow near the nose can be determined and further a formula relating the initial curvature K_W of the shock to the curvature K_S of the body surface in a meridian plane is derived. Finally the conical shock and the attached shock of a sharp-nosed body are discussed on the basis of this formula. In the axially symmetrical case it is pointed out that the curvature of the shock exhibits a singular behaviour at the Crocco point as in the two-dimensional case. A.

533.6.08

2490. Corrections in hot-wire correlation measurements. C. E. PEARSON. *Quart. appl. Math.*, **12**, *No.* 3, 235–40 (*Oct.*, 1954).

Particularly in small-scale turbulence, hot-wire correlation measurements must be corrected for the effect of finite wire length. End effects, imperfect velocity correlation along the length of the wire and transient longitudinal heat conduction must be considered. An integral equation for these corrections is obtained; with appropriate experimental procedure, this equation may be solved explicitly. A.

MOLECULAR THEORY OF GASES 533.7

533.7

2491. Second virial coefficient between unlike molecules. T. KIHARA AND S. KOBA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 688–9 (*Sept.–Oct.*, 1954).

By means of the core model of molecules introduced by Kihara [Abstr. 4261 (1954)], potentials between

unlike molecules in nonpolar gases have been determined from the second virial coefficients. The intermolecular potential U_{AB} for the pair of molecules (A, B) is assumed to be a function of the shortest distance ρ between the cores of the molecules, and furthermore $U_{AB}(\rho) = U_{0AB}[(\rho_{0AB}/\rho)^{12} - 2(\rho_{0AB}/\rho)^{6}]$. Here U_{0AB} and ρ_{0AB} are constants which have been determined. Regarding these model constants the following relations have been verified: $\rho_{0AB} = \frac{1}{2}(\rho_{0AA} + \rho_{0BB})$, $U_{0AB} = (U_{0AA}U_{0BB})^{1/2}$. A.

533.7

2492. Mixtures of rigid spherical molecules. B. J. ALDER. *J. chem. Phys.*, **23**, *No.* 2, 263–71 (*Feb.*, 1955).

The radial distribution functions for binary mixtures of rigid spheres with a size ratio of 3 to 1 have been calculated at several mole fractions and at several densities by numerical solution of a set of integral equations obtained with the use of the superposition approximation. The distribution functions have then been used to evaluate the relevant thermodynamic properties of the system. A.

533.75 : 541.126

2493. An equation of state for the detonation of condensed explosives. M. P. MURGAI. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 548–56 (*Sept.–Oct.*, 1954).

The range of validity of Corner's equation of state, hitherto applied by him to the investigation of the properties of propellants, has been extended to higher pressure regions by the application of the hydrodynamic theory of detonation and the results applied to the determination of the detonation parameters of O_2-balanced and O_2-negative explosives. An estimate of the third virial coefficient of the methane gas has been made. A.

VIBRATIONS . ACOUSTICS 534

534.121.1 : 534.143

2494. Excitation of flexural vibrations of metallic plates with the aid of polycrystalline barium titanate. I. S. ZHELUDEV. *Zh. tekh. Fiz.*, **24**, *No.* 8, 1467–73 (1954) In Russian.

A number of metal plates (Dural, aluminium, iron) 10 cm square were thickly coated with a mixture of powdered barium titanate and an adhesive binder. A thin metal foil electrode was laid over the titanate and the assembly heavily pressed. The metallized titanate took various shapes, small squares, diagonal strips, crosses, etc. The metal plates were of the order of 1 mm thick. The mount was excited at various frequencies up to 21 kc/s and photographs taken of the resultant Chladni figures. More than 20 distinct patterns were observed. These are tabulated and correlated with the kind of metal and the frequency. S. C. DUNN

534.13

2495. The vibrations of a stressed framework. H. C. LONGUET-HIGGINS. Letter in *Phil. Mag.*, **46**, 98–100 (*Jan.*, 1955).

Equations are derived for the normal modes of vibration of a system of massive particles connected in pairs by light springs. The particular case is considered of a system in which the number of springs exceeds the number of internal degrees of freedom. It is shown how the vibrational modes depend on the equilibrium stresses as well as on the force constants of the springs. G. F. HODSMAN

534.14

2496. Shock-tube measurements of vibrational relaxation. E. F. SMILEY AND E. H. WINKLER. *J. chem. Phys.*, **22**, *No.* 12, 2018–22 (*Dec.*, 1954).

Vibrational relaxation times at temperatures between 400°K and 1500°K have been measured in chlorine and carbon dioxide with a shock tube. The approach toward equilibrium vibrational excitation behind the shock wave is obtained from the density profile of the transition region using an optical interferometer. The measurements were made with a relatively narrow shock tube in order to avoid errors caused by optical distortions. The accuracies of the measured relaxation times are estimated to be from 20% to 50%. A.

534.141.3

2497. Note on the minimum bowing pressure. K. C. KAR. *Indian J. theor. Phys.*, **2**, *No.* 1, 47 (*June*, 1954).

Refers to an earlier paper [Abstr. 5611 (1952)] in which the minimum bowing pressure $P_{\min}$ required to excite a musical note was derived. The formula obtained, however, did not explain the variation of $P_{\min}$ with the frequency of the note, as observed by C. V. Raman in 1920. In the present paper a further term is introduced in the expression for $P_{\min}$ which allows for this frequency effect. The additional term P_0 is required on account of the yielding of the bridges and the effect of the backing resonator.

A. B. WOOD

534.141.4

2498. Whistles. Theory of operation and performance. V. GAVREAU. *Acustica*, **4**, *No.* 5, 555–62 (1954) In French.

Theoretical and experimental study of police whistles from which ultrasonic sirens are derived—experimental proof of the fact that edge tones are not formed in the whistles in normal operation—different types of whistles for audio and ultrasonic frequencies —theory of operation and derivation of equations for the output of a whistle—experimental confirmation of these results. A.

534.141.4

2499. Metastable jet-tone states of jets from sharp-edged, circular, pipe-like orifices. A. B. C. ANDERSON. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 13–21 (*Jan.*, 1955).

Characteristics of spectra from relatively thick orifices differ from those from relatively thin. In a given range of Reynolds number, in many cases the jet may exist in any one of several reproducible jet-tone states (metastable states) characteristic of the orifice. The dependence of the component frequencies of the jet-tone spectra [expressed in terms of the orifice number $fd/(\Delta p/\rho)^{\frac{1}{2}}$] on Reynolds number $[\rho d(\Delta p/\rho)^{\frac{1}{2}}]/\mu$ is shown, where d is diameter of orifice; f, frequency; Δp, pressure difference across orifice; ρ, density; and μ, viscosity of gas. The orifice

numbers of the components of the jet-tone spectra generally tend to fall on a single array of equally spaced orifice-number levels. Jet tones from the same orifice plate, characteristic of both thin as well as thick orifice plates, are found to coexist over a small transition range of orifice thickness-diameter ratio. If the orifice number of the head of the most probable spectral mode for a given orifice thickness-diameter ratio is noted, the same will be found again for the head of the most probable mode at approximate orifice thicknesses $t \pm nd$, where n is a small integer. A.

534.142.3

2500. Model study of air-coupled surface waves. F. Press and J. Oliver. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 43–6 (*Jan.*, 1955).

Flexural waves generated in a thin plate by a spark source are used to investigate properties of air-coupled surface waves. Both ground shots and air shots are simulated in the model. Effects of source elevation, fetch of air pulse, and cancellation by destructive interference are studied. A.

534.143 : 621.373.1

2501. Piezoelectrically-activated low-frequency mechanical resonators. J. F. W. Bell. *J. sci. Instrum.*, **32**, *No.* 2, 52–4 (*Feb.*, 1955).

Mechanical resonators using two piezoelectric crystals have been studied as four-terminal networks. The constants of the equivalent electrical circuit have been determined for a number of flexural modes of various circular plates supported at the centre, i.e. the Chladni's plate type of resonator. A 1000 c/s oscillator with frequency stability of a few parts in 10^4 using a 2 in. diameter plate is described. A.

534.17

2502. Simple derivation of the Boltzmann–Ehrenfest adiabatic principle. M. Greenspan. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 34–5 (*Jan.*, 1955).

The time-average forces exerted by the constraints of a vibrating system (radiation pressure, mean tension in a vibrating string, etc.), are easily computed from the adiabatic principle of Boltzmann and Ehrenfest (BE principle). The usual derivation from the "principle of varying action" is difficult. Here an equivalent principle (which gives in addition the time dependence of the forces) is derived from Lagrange's equations. It is also shown how similar results can be got from the solution of a linear differential equation with slightly variable coefficients. A.

534.21 : 539.319

Acoustic methods of measuring relaxation spectra in solids. *See Abstr.* 3183

534.213 : 532.51

2503. Steady rotational flow of an incompressible, viscous fluid enclosed between two coaxial cylinders. S. Skavlem and S. Tjötta. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 26–33 (*Jan.*, 1955).

Gives a theoretical study of the two-dimensional flow of an incompressible, viscous fluid enclosed between two coaxial cylinders, one of which is oscillating. The Reynolds number is assumed to be small, and the Navier–Stokes differential equations are solved by means of the method of successive approximations. Both for the first- and second-order solution the proper boundary conditions are applied. It is shown that there exist two stationary circulation systems in every quadrant, and that the direction of circulation is opposite in these two systems. The circulation velocities are calculated in detail, and the results are compared with experimental results referred to in an earlier paper. Some new experimental results, which are not published yet, are briefly mentioned. The agreement between theoretical and experimental results is excellent. An explanation is given of the remarkable fact that in some experiments the direction of circulation seems to reverse when the oscillation amplitude increases and exceeds a certain critical value. A.

534.22

2504. Variations of the velocity of ultrasound in propane as a function of temperature and pressure. A. Lacam. Letter in *J. Phys. Radium*, **15**, *No.* 12, 830–1 (*Dec.*, 1954) In French.

Detailed results are given for the gaseous phase. At low pressures velocity increases with temperature but as pressure is increased the relative position of the isotherms is inverted and pressure decreases with temperature. G. F. Hodsman

534.22

2505. Velocity of ultrasound of 585 kc/s in propane in the region of the critical state. J. Noury. Letter in *J. Phys. Radium*, **15**, *No.* 12, 831–2 (*Dec.*, 1954) In French.

Detailed results are given showing how the velocity varies with pressure at five different temperatures close to the critical temperature. G. F. Hodsman

534.22

2506. Variations in the velocity of ultrasound in methane as a function of temperature and pressure. A. Lacam. Letter in *J. Phys. Radium*, **16**, *No.* 1, 72–3 (*Jan.*, 1955) In French.

Utilizing a new apparatus which permits large variations in temperature, previous results [see Abstr. 8286 (1953), 8999 (1954)] for methane have been extended up to 200°C. Detailed results are given. G. F. Hodsman

534.22

2507. Ultrasonic dispersion in methyl alcohol vapor. C. Ener, A. Busala and J. C. Hubbard. *J. chem. Phys.*, **23**, *No.* 1, 155–9 (*Jan.*, 1955).

Ultrasonic velocities have been measured at temperatures of 32°C, at pressures from 1·12 to 16 cm Hg, and at frequencies from 0·2 to 2·0 Mc/s. A systematic variation with pressure of several per cent in the measured values of velocity at the lower frequencies is attributed in large part to dimerization of the vapour. Previously determined constants in state equations for methanol have not been found adequate to reconcile the values of velocity at the higher pressures, but empirical values not far from those found by Weltner and Pitzer are satisfactory. There remains evidence of a thermal dispersion of velocity, attributed to internal rotation with a relaxation frequency of 100 Mc/s atm^{-1}, corresponding to a relaxation time of $2{\cdot}27 \times 10^{-9}$ sec. A.

534.22 : 532.7

2508. Molecular sound velocity and molecular compressibility of organic halogen compounds. O. NOMOTO. *J. Phys. Soc. Japan*, **10**, *No.* 1, 31–5 (*Jan.*, 1955).

Molecular compressibility $W = (M/\rho)\beta^{-1/7}$ and molecular sound velocity $R = (M/\rho)V^{1/3}$ were computed for organic halogen compounds employing existing ultrasonic velocity data and the halogen increments were obtained, also making use of the values of the molecular sound velocity and the halogen increments given by Lagemann, Evans, and McMillan. (M = molecular weight, ρ = density of the liquid, V = sound velocity in the liquid, β = adiabatic compressibility of the liquid.) The deviation from additivity rules with respect to the constitutive elements of the molecule is somewhat smaller for the molecular compressibility than for the molecular sound velocity, the percentage deviation for halogen increments of the molecular compressibility being about $1/2 \sim 2/3$ as compared with the percentage deviation for halogen increments of the molecular sound velocity. A.

534.22 : 536.22 : 536.63 : 532.14

On the relation between the dispersion of the velocity of sound, the specific heat, the density and the thermal conductivity of glycerine. *See Abstr.* 2457

534.222.2

2509. Unstationary strong shock-wave fronts. K. HAIN AND S. V. HOERNER. *Z. Naturforsch.*, **9a**, *No.* 12, 993–1004 (*Dec.*, 1954) In German.

The case of a strong, plane, unstationary shock wave entering a space filled with constant density gas, e.g. an interstellar cloud, is treated. A procedure, based on the method of characteristics, is presented for calculating velocity, density and pressure distributions behind the front as functions of time, starting with any given initial distributions. With no momentum transfer from the front backwards, all initial distributions are shown to tend with time to Weizsäcker's homologous solution [Abstr. 8109 (1954)] with the parameter $K = 0{\cdot}39 \pm 0{\cdot}01$, or better still to Häfele's singular solution of homologous equations (*ibid.*, published later). A. GELBTUCH

534.222.2

2510. Graphical representation of the spherical propagation of explosive pulses in elastic media. W. GOLDSMITH AND W. A. ALLEN. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 47–55 (*Jan.*, 1955).

The problem of spherically symmetric wave propagation in homogeneous, isotropic elastic media of infinite extent has been examined frequently in recent years, and a number of analytical solutions have been reported in the literature for various initial conditions. Some interest has also been exhibited in the application of these relations to the transient phenomena occurring in metals when subjected to contact explosions. Under these conditions, an actual wave system can be approximated by postulating the existence of a spherical cavity in the interior of the medium and applying as the initial condition a pulse of exponentially decaying character. While no difficulty is encountered here in an analytic expression of the displacements, velocities and stresses occurring at each point of the medium as a function of location and time, it has been found highly desirable to represent these terms in pictorial form to permit a rapid evaluation of the nature of the disturbances in the region of interest. Consequently, numerical calculations have been performed on an IBM machine and the resultant data have been employed in a space-time representation of these parameters. A.

534.222.2

2511. Gaseous detonations. VI. The rarefaction wave. G. B. KISTIAKOWSKY AND P. H. KYDD. *J. chem. Phys.*, **23**, *No.* 2, 271–4 (*Feb.*, 1955).

For Pt V, see Abstr. 6834 (1952). The density profile of the rarefaction wave which follows a detonation has been determined using the technique of X-ray absorption measurements to follow rapid gas density changes. The observed density-time dependence was found to agree, within experimental errors, with the predictions of the hydrodynamic theory developed by Taylor, Doering and others. As the theory predicts, the density in the rarefaction wave decreases for approximately one-half of the distance travelled by the detonation wave; behind this is the region of quiescent gas at constant density. A.

534.222.2

2512. On the propagation of shock waves in regions of non-uniform density. C. W. JONES. *Proc. Roy. Soc. A*, **228**, 82–99 (*Feb.* 15, 1955).

534.222.2 : 535.332 : 537.564

Highly ionized argon produced by shock waves. *See Abstr.* 2569, 2830

534.222.2 : 537.311.37 : 541.126

2513. On electrical conductivity in detonation and shock waves, and the measurement of detonation and shock velocities. M. BIRK, A. EREZ, Y. MANHEIMER AND G. NAHMANI. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 398–413 (*March*, 1954; publ. *June*, 1954).

The electrical conductivity between two electrodes on the explosive or in the air close to it is investigated with a view to obtaining data pertaining to the design of probes. Theoretically relations are derived for the electron velocity and the current density, and it is deduced that the gas in the detonation zone cannot be in a state of equilibrium. The conductivity between two electrodes on an explosive charge as well as the detonation and shock velocities were measured. The apparatus used and the electronic circuit are described. A few applications are mentioned.

A. J. TAYLOR

534.23

2514. Measurements of the absorption of ultrasonic waves in liquids by the method of isochromates. M. M. KANNUNA. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 5–8 (*Jan.*, 1955).

The method of isochromates was used to measure the absorption of ultrasonic waves in *m*-xylene, toluene, carbon tetrachloride and benzene. The results are summarized in a table. A.

534.23 : 532.7

2515. Ultrasonic absorption in glycols, cyclohexanol and cresol. T. KISHIMOTO AND O. NOMOTO. Letter in *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1081 (*Nov.*, 1954).

Ultrasonic absorption coefficients measured by

pulse technique bear a fixed ratio to the classical absorption coefficient. The value of the ratio depends upon the type of liquid but not upon the temperature, thus showing molecular absorption in these liquids to be unimportant at the frequencies used (8 Mc/s). T. C. TOYE

534.23 : 532.7

2516. Absorption of ultrasonic waves in organic liquids. II. Liquids with negative temperature coefficient of sound absorption (*a*) glycols, cyclohexanol and cresol. T. KISHIMOTO AND O. NOMOTO. *J. Phys. Soc. Japan*, **9**, *No.* 6, 1021–9 (*Nov.–Dec.*, 1954).

For Pt I, see Abstr. 9991 (1954). Ultrasonic absorption coefficients (at about 8 Mc/s) were determined by the pulse technique in relation to the temperature. Also the ultrasonic velocity (at 1·43 Mc/s) in these liquids was determined by ultrasonic interferometry. The experimental absorption coefficient α_{exp} in these liquids decreased with increasing temperature in a manner similar to that of classical sound absorption due to viscosity α_{vis}. In most of the liquids investigated, however, α_{exp} was higher than α_{vis}, and the excess absorption was attributed to the bulk viscosity due to the hydrogen bond association in these liquids. The ratio $\alpha_{exp}/\alpha_{vis}$ was nearly independent of the temperature for all these liquids, the mean values of this ratio being given by: ethylene glycol 4·88; diethylene glycol 2·23; triethylene glycol 0·98; polyethylene glycol 0·89; propylene glycol 1·46; cyclohexanol 1·14; and *m*-cresol 1·32. The low value of the ratio for polyethylene glycol is considered to be due to experimental errors, especially those in determination of the static viscosity. The activation energies of the shear and the bulk viscosity were determined from their temperature-dependences, the latter being calculated from the excess absorption. The two activation energies are nearly the same for the same liquid, being of the order of 8 to 10 kcal/mole for most of the liquids here investigated, though slightly lower for ethylene glycol and much higher for *m*-cresol. The molecular sound absorption, if present, is small, and presumably less than $\alpha_{mol}/\nu^2 = 30 \sim 60 \times 10^{-17}$ (α_{mol} = absorption coefficient due to this mechanism, ν = frequency) for most of the liquids investigated. Also ultrasonic absorption (at 24 Mc/s) in water was determined and was found to be in good agreement with the existing results. A.

534.23 : 532.7

2517. Ultrasonic absorption in toluene. R. T. BEYER. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 1–4 (*Jan.*, 1955).

The ultrasonic absorption coefficient has been measured in toluene by means of the spherical resonator method of Leonard and Wilson. Measurements were made in the temperature range 6°–40°c and in the frequency range 50–400 kc/s. The existence of a relaxation peak in this region, previously reported by Moen, has been confirmed, and a second peak has been identified at a lower frequency. The temperature dependence of the first peak indicates a heat of reaction of 5·2 kcal/mole and an activation energy of 8·5 kcal/mole. This result is inconsistent with the hypothesis of a stretching vibration of the C–H bond, and suggests some sort of structural source for the absorption. A.

534.23 : 537.311.31

2518. Ultrasonic attenuation due to lattice-electron interaction in normal conducting metals. W. P. MASON. Letter in *Phys. Rev.*, **97**, *No.* 2, 557–8 (*Jan.* 15, 1955).

Bömmel's data [Abstr. 969 (1955)] are interpreted as due in the normal state to transfer of momentum from lattice vibrations to electrons, damped by viscosity of the electron gas; the damping is supposed to disappear in the superconducting state due to impossibility of momentum transfer. The viscosity should be proportional to electrical conductivity, and the calculated temperature variation of the attenuation deduced from that of the conductivity agrees well with Bömmel's data for lead and tin. D. SHOENBERG

534.231.3

2519. On the contribution of a contained viscous liquid to the acoustic impedance of a radially vibrating tube. D. H. ROBEY. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 22–5 (*Jan.*, 1955).

The impedance presented to the inside surface of a hollow, liquid-filled, radial cylinder of finite length has been determined theoretically. It was assumed that the liquid was retained by pressure-release caps or one pressure-release cap and one rigid cap at each end. For a loss-free liquid it is shown that the reactance presented to the cylinder wall becomes infinite whenever the liquid has a longitudinal or coupled radial resonance. A sizeable resistance may appear when a viscous liquid is used. This is because the geometry of the arrangement is ideal for creating large shear losses. Exceptions to this occur for high frequencies where the wavelength is small in comparison to the cylinder length. A.

534.232

2520. Condenser transmitters and microphones with solid dielectric for airborne ultrasonics. W. KUHL, G. R. SCHODDER AND F.-K. SCHRÖDER. *Acustica*, **4**, *No.* 5, 519–32 (1954).

The development of condenser transmitters and microphones with solid dielectric, which are applicable to high-frequency ultrasonics, is described. Mechanical construction, presumable mode of operation, sensitivity, frequency response, mechanical tuning, directional characteristics, linearity, influence of the electrical bias, and charging phenomena are discussed. Finally, the calibration of the microphones in a free sound field making use of the reciprocity method is described. A.

534.232

2521. Investigations on the properties of ferrites as transducers for liquids. H. THIEDE. *Acustica*, **4**, *No.* 5, 532–6 (1954) In German.

The uses to which a magnetostrictive transducer may reasonably be put and the measurements necessary to judge the usefulness of the material for this purpose are examined. Test results obtained from various ferrite samples are given showing that such materials may be eminently suitable for transducers in liquids. Their properties are discussed. A.

534.232

2522. Some aspects of the non-linear distortion of loudspeakers. C. BORDONE. *Acustica*, **4**, *No.* 5, 563–6 (1954).

Measurements have shown that this depends greatly upon the frequency and direction of radiation. When describing the nonlinear behaviour of loudspeakers more attention should be paid to this fact than hitherto. A.

534.232 : 621.395.61

2523. Notes on the stabilization of the response of a condenser microphone. C. COLIN. *J. Phys. Radium*, **15**, *No.* 12, 820–2 (*Dec.*, 1954) In French.

A mathematical analysis of the behaviour of a condenser microphone when in-phase feedback is applied to the membrane through an additional electrode. H. G. M. SPRATT

534.25 : 532.7

2524. Acoustic birefringence in a solution of flexible molecules. J. BADOZ. Letter in *J. Phys. Radium*, **15**, *No.* 11, 777–8 (*Nov.*, 1954) In French.

The theory of birefringence for elastic sphere molecules is extended to solutions of flexible macromolecules, an equation being derived for the deformations which would be produced in such viscoelastic particles. T. C. TOYE

534.25 : 548.7

2525. Internal conical refraction of transverse elastic waves in a cubic crystal. J. DE KLERK AND M. J. P. MUSGRAVE. *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 2, 81–8 (*Feb.*, 1955).

A general method for obtaining the elastic wave surface appropriate to any aeolotropic medium is used to investigate the behaviour of transverse plane waves of normal (1, 1, 1) in a cubic crystal. It is shown that the conditions for internal conical refraction prevail; this prediction has been verified experimentally. A.

534.26

2526. Sound propagation into the shadow zone in a temperature-stratified atmosphere above a plane boundary. D. C. PRIDMORE-BROWN AND U. INGARD. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 36–42 (*Jan.*, 1955).

The sound field in the "shadow zone" (diffraction region) formed over a plane boundary in an atmosphere with a constant vertical temperature gradient is analysed both theoretically and experimentally. The boundary condition at the plane is given by a normal acoustic impedance independent of the angle of incidence. As in the corresponding problem of underwater sound where the boundary is a pressure release surface, it is found that the major portion of the sound pressure in the shadow zone decays exponentially with distance at a rate proportional to the one-third power of frequency and two-thirds power of temperature gradient. The effect of boundary impedance enters mainly through its resistive component. The rate of sound decay for a pressure release boundary (zero impedance) is found to be 2·3 times that for a rigid boundary (infinite impedance). Sound pressure measurements in the shadow zone in a laboratory chamber in which a large temperature gradient was created were made for both hard and absorbing boundaries, and the results were found in essential agreement with theory. A.

534.26 : 538.566

2527. Diffraction of pulses by a circular cylinder. F. G. FRIEDLANDER. *Commun. pure appl. Math.*, **7**, *No.* 4, 705–32 (*Nov.*, 1954).

A mathematical investigation of the behaviour of the sound pressure behind a diffracted front in the specific case of a circular cylinder—the incident pulses being two-dimensional. The problem formulated and solved in this paper can also be interpreted in electromagnetic terms. A. B. WOOD

534.321.9 : 539.576 : 621.9.01

2528. Ultrasonic machining by low power vibration. A. NOMOTO. Letter in *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1081–2 (*Nov.*, 1954).

An amplitude of 10 microns and a frequency of 26·2 kc/s are used. Results given for the piercing of a glass plate with carborundum abrasives show how the efficiency varies with static load and tool diameter. The behaviour of the abrasives between the tool and the work is shown to be the principal factor in determining efficiency. G. F. HODSMAN

534.322.1 : 534.112

2529. New study of the vibration of strings in musical instruments. B. BLADIER. *J. Phys. Radium*, **15**, *No.* 12, 65 S–67 S (*Dec.*, 1954) In French.

The timbre of a violin or cello is, in a certain measure, modified if the strings are changed, for their mode of vibration determines the number, place and relative intensity of the partials superposed on the fundamental. An investigation is described to ascertain the differences between similar strings which might give rise to differences of timbre. In particular the influence of the rosin applied to a string has been studied—a standard form of bowing being applied with a definite velocity at a definite distance from the bridge. Wave forms are compared when the strings have and have not been rosined, revealing marked differences in the partial tones both in amplitude and relative position. A comparison is also made using strings of aluminium, silver and tungsten. A. B. WOOD

534.39 : 771.5

2530. Effect of ultrasonic energy applied during the after-ripening stage of photographic emulsion preparation. R. C. HEROLD, J. B. JONES AND C. D. KNIGHTON. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 9–12 (*Jan.*, 1955).

When a photographic emulsion of the boiled type is treated with 800 kc/s ultrasonic energy at an energy level of 5 W/sq cm during the after-ripening or digestion period, an increase in the photographic sensitivity of that emulsion occurs. No significant change in the γ or the grain-size distribution of the emulsion results from this treatment. The mechanism appears to be a transport phenomenon which disrupts grain-sensitizing-agent concentration gradients in the intergrain gelatin matrix. A.

534.512.1

2531. Localization of particles in standing ultrasonic waves. G. KECK. Note in *Naturwissenschaften*, **41**, *No.* 21, 495 (1954) In German.

It has been observed that in some cases, particles

used to indicate standing waves in liquids do not sink to the bottom at the nodes but form bands perpendicular to the direction of propagation.

T. C. TOYE

534.6 : 534.833.1

2532. A tentative method for the measurement of sound transmission losses in unfinished buildings. A. C. RAES. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 98–102 (*Jan.*, 1955).

The method attempts to measure the transmission loss of any wall independently of the surrounding elements of the building. The extreme case of a wall without any surrounding elements, i.e. the first wall in a building under construction, is included in the problem. A.

534.61

2533. The subjective free-field calibration of an external telephone receiver by the equal-loudness method. J. PRITCHETT. *Acustica*, **4**, *No.* 5, 544–6 (1954).

The subjective calibration of an external receiver in terms of pure tone free-field sound pressures is described. The method is based upon the balance of two sound sources for equality of loudness sensation. Comparison is made with the calibration of the receiver in terms of the sound pressure measured when it is held to the ear. A.

534.614 : 539.16.08

2534. On the measurement of the velocity of ultrasound in liquids by radioactive indicators. T. T. OUANG. Letter in *J. Phys. Radium*, **15**, *No.* 10, 697 (*Oct.*, 1954) In French.

The radioactive element is suspended as very fine particles in the liquid and standing waves are set up, whereupon the nodes can be detected by their maximum emission. The quantity of radioactive material required is too small to affect the purity of the liquid or to itself cause dispersion of the sound wave.

T. C. TOYE

534.7

Physiological acoustics. Hearing. *See also under* "Medical science. Human physiology." Decimal classification 612.85.

534.773

2535. Factors determining the sound attenuation produced by earphone sockets. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 146–54 (*Jan.*, 1955).

The factors that determine the sound attenuation provided by earphone sockets are analysed on the basis of experimental evidence, and an attempt is made to determine the practical limit of sound attenuation attained by earphone sockets, when comfort and sound transmission from the earphone to the ear are taken into consideration. For frequencies below 700 c/s the attenuation is limited by the mass of the system and the impedance of the flesh under the earphone cushion. For frequencies above 700 c/s bone conduction is the determining factor. A.

534.773 : 621.395.623.6

2536. The development of a semiplastic earphone socket. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 155–61 (*Jan.*, 1955).

The semiplastic earphone socket is characterized by high internal viscosity and low elasticity. It can be deformed easily, but in the absence of external forces comes back to its original shape. The high viscosity has a strong sound-attenuating effect. The paper describes the developmental steps leading to the design of a circumaural semiplastic socket and the performance of the socket. Its most outstanding features are high noise-attenuation and comfort. A.

534.78

2537. An instantaneous pitch-period indicator. L. O. DOLANSKÝ. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 67–72 (*Jan.*, 1955).

Instantaneous indication of the beginnings of individual pitch periods of a voice-sound speech wave is often desirable in speech analysis. With conventional means, such as linear filtering and subsequent waveform shaping, this instantaneous indication is very hard to achieve because of the considerable time delay involved. In the "instantaneous" pitch-period indicator the problem is solved by using non-linear techniques and a variable time-gating circuit; a pitch-period beginning is indicated by a marker pulse having a maximum delay of the order of 5% of the pitch-period duration. The application of the device to certain problems of speech analysis is indicated. A.

534.78

2538. The transmission of the vocal cavities. J. VAN DEN BERG. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 161–8 (*Jan.*, 1955).

The transmission of the vocal cavities has been determined for eleven cardinal vowels of the I.P.A., using a hemilaryngectomized subject. A special throat loudspeaker with pick-up was constructed and was fitted in the throat of the subject, leaving a gap beneath it for normal breathing. A.

534.78

2539. Imitation of Dutch vowels and words by a hemilaryngectomized subject using a throat loudspeaker as a pseudolarynx. J. VAN DEN BERG. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 169–72 (*Jan.*, 1955).

Using a specially constructed throat loudspeaker, Dutch vowels and words were imitated by a hemilaryngectomized subject. A known mixture of harmonics was delivered to the larynx, and the subject shaped his mouth in agreement with the desired sound. Conclusions are drawn about the most effective harmonic spectrum at the larynx, and about the so-called vowel pattern in the larynx. A.

534.831

2540. Perstimulatory auditory fatigue for continuous and interrupted noise. E. C. CARTERETTE. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 103–11 (*Jan.*, 1955).

Perstimulatory fatigue, or adaptation, is measured by a simultaneous loudness balance or median plane localization of a dichotically presented acoustic stimulus. After one ear has been stimulated for a period of time, it is usually found that the variable or comparison stimulus must be reduced below the prefatiguing intensity in order to maintain the loudness match or localization balance. Five observers made median plane localizations of a continuous 100–5000 c/s band-pass noise before, during and after a seven-minute fatiguing period. The fatiguing stimuli were continuous noises at 30, 60, 87 and

100 db SPL, and noises interrupted at 1, 2, 5, 9 and 12·5 i.p.s. (intervals per sec) with both burst level and noise-time fractions held constant at 90 db SPL and 0·5, respectively. It was found that (*a*) the time required for fatigue to reach an apparent asymptote is at least seven minutes, about twice that required for pure tones; (*b*) the maximum fatigue increases with the intensity of the fatiguing stimulus and the function is positively accelerated; (*c*) for a fixed intensity of fatiguing noise, the maximum fatigue for the highest rate of interruption used (12·5 i.p.s.) is less than that obtained with a continuous noise having the same over-all level (87 db). During the course of fatigue, the between-observer variations (standard deviations) of the balances tend to be greater than the within-observer variations; the reverse is true for the post-fatigue period. A.

534.831

2541. Perstimulatory fatigue as measured by heterophonic loudness balances. J. P. EGAN. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 111–20 (*Jan.*, 1955).

Perstimulatory fatigue (see preceding abstract) has been measured in the past by requiring a simultaneous dichotic loudness balance between two pure tones of the same frequency, one in each ear. Under these conditions the listener hears a single phantom sound whose localization depends upon the relative intensities of the two tones. The present investigation shows that the process of localizing the sound image in making the loudness balance is not critical to the occurrence of perstimulatory fatigue. Two principal conditions were compared. In the first, the frequency of the comparison stimulus was the same as that of the fatiguing stimulus. In the second, the comparison and fatiguing stimuli differed sufficiently in frequency so that the listener always heard two pure tones which he could correctly localize in the two ears. It is concluded that the amount of perstimulatory fatigue is very nearly the same under these two conditions. In the early phases of the present research it was suspected that the loudness balances were influenced by absolute judgments of loudness. A procedure is developed which precludes the formation of a single absolute standard of loudness. This method results in greater measured fatigue than the usual procedure. A.

534.837

2542. Noise control for NACA supersonic wind tunnel. L. L. BERANEK, S. LABATE AND U. INGARD. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 85–98 (*Jan.*, 1955).

To reduce an intense noise with frequency components extending from 5 to 10 000 c/s due to the burning of a jet engine in the test section of a supersonic wind tunnel, a special muffler was built having an open cross-sectional area of 600 square feet. For frequencies below 11 c/s, large Helmholtz-type resonators were used. Between 11 and 20 c/s intermediate-sized Helmholtz resonators were employed. Between 20 and 800 c/s a tuned set of six Fiberglas-lined square ducts were constructed. At higher frequencies two lined bends were employed to reduce the noise. Performance data measured in models and in the full-scale wind tunnel are presented. The result is a wind tunnel that is so quiet that nearby listeners are unaware of its operation. A.

534.844

2543. Arrangements for the production of artificial reverberation. H. SCHIESSER. *Funk u. Ton*, **8**, *No.* 7, 361–8 (*July*, 1954) In German.

After considering the reverberation characteristics of halls and studios, the author deals with the artificial production of reverberation effects. It is shown how the long-period decay of reverberation in a hall can be combined with the short period of a studio—to produce large-hall effects in a small studio. Reference is made to the mechanical reverberation arrangement in the Hammond electrical organ—a system combining coupled masses, springs and damping. Methods of producing mechanical, ultrasonic and magnetic delays and their application in the control of reverberation time are described. A. B. WOOD

OPTICS . RADIATION . SPECTRA 535

535.1

2544. The radiation Green's functions. J. G. LINHART. *J. Franklin Inst.*, **258**, *No.* 2, 99–112 (*Aug.*, 1954).

Presents a method of calculating the radiation field of a group of charges by using the "radiation Green's function." The latter represents a concept similar to that of the Green's function in the potential theory, only its application is directed to the time variables problems of the radiation theory. Its usefulness is demonstrated by examples taken from the problems connected with microwave oscillators. A.

535.223 : 535.33

2545. Velocity of light from the molecular constants of carbon monoxide. E. K. PLYLER, L. R. BLAINE AND W. S. CONNOR. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 102–6 (*Feb.*, 1955).

By infrared spectroscopy precise measurements of the wavelengths of 43 rotational lines in the CO absorption band at 4·67 μ were made; 15 lines from $J = 32$ to $J = 52$ in the P branch were measured from the emission spectrum of CO. These data were reduced by the method of least squares, and values of the rotational constants, B_0 and D_0, of CO were calculated. A second, slightly less precise set of measurements over approximately the same range of J values was similarly reduced, and combined estimates of the constants were obtained. Using the resulting value of B_0 with the value obtained from microwave frequency measurements, the velocity of light was estimated to be 299 792 km/sec. The estimated standard deviation of this value is 6 km/sec. A.

535.243 : 535.33.07 : 621.389

2546. Microphotometer scans spectrum photographs. D. E. BILLINGS, R. H. COOPER, J. W. EVANS AND R. H. LEE. *Electronics*, **27**, *No.* 12, 174–8 (*Dec.*, 1954).

This instrument compares the densities of the subject spectrogram with those of a standardizing spectrogram, the latter being produced, from the spectrograph employed, by an incandescent source photographed when a wedge of varying density is placed over the collimator slit. The two spectrograms

are mounted side by side on a carriage. As this carriage moves sideways, both spectrograms are scanned simultaneously by separate beams which then pass through optical systems to a quarter-wave plate, Kerr cell and Polaroid. The Kerr cell is driven from an r.f. switching voltage and the optical axes of the system are so oriented that the two emerging rays form the ordinary and extraordinary rays. The rays fall on a multiplier photocell which accordingly has an alternating output component except when the two beams are equal in intensity. This alternating component passes to a phase-sensitive detector which in turn drives an electronic pen recorder. The deflection of this record is α the time interval between the instant when the beams are equal and some reference point in the cycle. From this data the variation of the intensity of the subject spectrogram can be determined.

H. G. M. SPRATT (R)

535.31

2547. Optimal optical systems. R. S. INGARDEN AND H. OCHMAN. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 6, 271–6 (1954).

The quality of the final diffraction image given by an optical system is defined in terms of the residual geometrical aberrations, and the conditions found for which the resolution of the system becomes a maximum. The possibility of obtaining higher resolution than that of an ideal, i.e. non-aberrational, system is shown.

R. W. FISH

535.31

2548. Linearization of ray-tracing formulae for bent rays. I. H. MARX. *Optica Acta*, **1**, *No.* 3, 127–40 (*Dec.*, 1954) In German.

The formulae are made linear by using approximations. Neglecting tertiary aberrations (in the case of monochromatic light these are the 7th order) the lateral aberration can be represented in matrix form as a function of the initial co-ordinates of the ray and of the Lange co-ordinates of construction.

A.

535.31 : 535.822.9 : 537.531

2549. First-order aberrations in asymmetric catoptical systems. Application to the total-reflection X-ray microscope. M. MONTEL. *Optica Acta*, **1**, *No.* 3, 117–26 (*Dec.*, 1954) In French.

A detailed study of astigmatism and distortion of asymmetrical reflecting systems, with special reference to the possibility of improving the results obtained with the total-reflection X-ray microscope. Various possibilities of correction are mentioned.

A.

535.313.2 : 551.521.1

Distribution of solar energy reflected by a parabolic mirror. *See Abstr.* 3331

535.317.1

2550. On the assessment of optical images. P. B. FELLGETT AND E. H. LINFOOT. *Phil. Trans A*, **247**, *No.* 931, 369–407 (1954).

In the formation of an optical image, each surface element of the object gives rise to a more or less blurred distribution in the image surface, of total brightness proportional to that of the object element. The image is the sum of these distributions in the appropriate sense: when the object is coherently lit, the image is built up by adding their complex amplitudes; when the object elements are regarded as incoherent it is the intensities which are added. The image formed by an optical system can be expressed as the convolution of the object with a spread function which characterizes the optical system. In systems for which the spread function does not change appreciably from one part of the field to another, the Fourier transform of the image is obtained to a sufficient approximation on multiplying the Fourier transform of the object with that of the spread function. More generally, this holds for any part of the field of a non-isoplanatic system over which the changes in the form of the spread function are small enough to be disregarded; such an area is called an "isoplanatism-patch." Working over such an area, an optical system can be regarded as a linear filter in which the Fourier components of the object reappear in the image multiplied by "transmission factors." These factors, first considered by Duffieux, depend on the aperture and aberrations of the system, and they are here evaluated in terms of an ikonal function. The qualities required of an optical image are so varied that an assessment valid over the whole range of practical applications seems out of the question. Two extreme cases are considered: (1) That the aim of an optical design is to produce an image which is directly similar to the object. This is appropriate when no process of image interpretation or reconstruction is envisaged. A criterion of image fidelity is proposed which gives a numerical measure of the resemblance of image to object in terms of the transmission factors of the optical system. (2) The aim is to produce an image containing the greatest possible amount of information about the object, without regard to the complexity of the interpretation processes which may be needed to extract it. Assessment is based on the information content of the image in Shannon's sense. This depends not only on the transmission factors of the system but also on the statistical properties of the presumed object set and of the unpredictable fluctuations which necessarily disturb observation.

A.

535.317.1

2551. Variation in distortion with magnification. A. A. MAGILL. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 148–52 (*March*, 1955).

The distortion introduced in the image by a lens for a given axial inclination of the chief ray is a linear function of the magnification. Specifically, if D_0 represents the distortion with parallel light incident on one side of the lens (zero magnification) and D_∞ the distortion with parallel light incident on the other, then the distortion D_m at any magnification m is given by: $D_m = D_0 - mD_\infty$. This equation has been experimentally verified for examples of three types of symmetrical lenses.

A.

535.317.6

2552. Extensions of the classification of geometrical aberrations to asymmetrical systems. M. MONTEL. *Rev. Opt.*, **33**, *No.* 11, 585–9 (*Nov.*, 1954) In French.

The extension of previous work [Abstr. 1141 (1954)] on the general classification of aberrations to two special practical cases: the application of Gouy's theorem to the case of first-order aberrations, and the use of several aperture diaphragms. It is shown how adjustment of the notations keeps the classification unchanged.

A.

535.32 : 539.23

2553. Dispersion of ZnS and MgF_2 films in the visible spectrum. J. F. Hall, Jr and W. F. C. Ferguson. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 74–5 (*Feb.*, 1955).

The dispersion and ageing effects of thin films of MgF_2 and ZnS were investigated in the spectral range of 4000 Å to 7500 Å. The method of evaporating ZnS is reported. The index of refraction was calculated from spectrophotometric reflectance measurements at extremes of reflectance. A.

535.322

2554. A hollow prism for the study of the variation of refraction of liquids with wavelength and temperature. A. Charru. *J. Phys. Radium*, **15**, *No.* 12, 63 S–64 S (*Dec.*, 1954) In French.

Practical details are given of a hollow prism, with a water jacket for temperature control. R. W. FISH

535.33 : 539.132

2555. Molecular spectroscopy. H. W. Thompson. *Nature* [*London*] **174**, 1165–7 (*Dec.* 25, 1954).

Report of a conference arranged by the Hydrocarbon Research Group of the Institute of Petroleum, Oct. 28–29 (1954), on the applications of molecular spectroscopy in pure and applied physics and chemistry.

535.33.03

2556. Equipment for excitation of spectra by high frequency pulses. L. Minnhagen and L. Stigmark. *Ark. Fys.*, **8**, *Paper* 46, 471–9 (1954).

The equipment consists of a pulse generator, which controls a Clapp oscillator followed by a frequency multiplier and amplifiers. The output frequency is about 9 Mc/s; the frequency and the duration of the pulses are adjustable within certain limits. With appropriate arrangements for bringing about optimum loading the average high-frequency power transferred to the discharge tube amounts to about 500 W and the peak power to approximately 3 kW. It is also possible to run the generator continuously. With argon as the filling-gas the continuous excitation gives the argon I spectrum and also spectrum lines of argon II, whereas the pulsed excitation produces argon I, II and III. In the latter case argon II is strongly enhanced and argon I weakened. A.

535.33.03

2557. Periodic processes in spark erosion of beryllium bronze. F. Rosendahl and H. Kaiser. Note in *Naturwissenschaften*, **41**, *No.* 21, 497 (1954) In German.

Briefly describes certain temporal variations in the intensity ratios of spectral lines (Be 2650 Å, Cu 3247 Å) in spark discharges between prepared electrodes. The work is relevant to spectroscopic analysis of impurities in metals. J. D. CRAGGS

535.33.07

2558. On the production of spectra on an oscillograph screen with the help of an oscillating slit. R. Herrmann. *Optik*, **11**, *No.* 11, 505–8 (1954) In German.

The entrance slit of a monochromator is vibrated by an electromagnet so as to move at right angles to the optic axis of the collimator and to the refracting edge of the prism. The amplified signal from the detector is displayed as a profile of part of the spectrum of the source. Difficulties inherent in the method are discussed. S. T. HENDERSON

535.33.07 : 535.243

2559. A nonpolarizing light modulator for the General Electric recording spectrophotometer. E. Atherton. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 130–1 (*Feb.*, 1955).

A method of modulating the light beams of the G.E. recording spectrophotometer is described, which does not involve the use of a polarizing prism, thus obviating de-cementing faults in the prism due to heating during prolonged operational periods. The performance of the modified instrument and its use in measurements of dichroism of dyed films are discussed. A.

535.33.07 : 535.375.5

2560. Photoelectric Raman spectrometer. J. U. White, N. L. Alpert and A. G. DeBell. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 157–66 (*March*, 1955).

This has been built for the measurement of small liquid and gas samples. Employing a 1200 line per millimetre replica grating, it can record a complete Raman spectrum in six minutes and a more accurate one in an hour. The precision of repeat readings is $\pm 1\%$. 5 cm^3 liquid samples are normally used, and methods are described for reducing the size to less than 1 cm^3. A.

535.33.07 : 535.343

2561. Spectral investigations in the region near 1 mm wavelength. I. Construction of the spectrometer and its basic spectrum. II. The rotation spectra of HCN and H_2S. L. Genzel and W. Eckhardt. *Z. Phys.*, **139**, *No.* 5, 578–91, 592–8 (1954) In German.

I. A description of an echellette grating spectrometer for 100 to 1400 μ with a high-pressure Hg arc source; quartz, paraffin and grating filters; and bolometer detection with time constant up to 200 sec. The H_2O vapour background absorption over this region is given.

II. The observed spectra of HCN and H_2S agree satisfactorily with predictions from observations in other ranges. D. H. WHIFFEN

535.33.07

2562. Feed-back resonance amplifier for the infrared spectrometry. III. H. Yosimura and K. Fukuda. *J. Phys. Soc. Japan*, **9**, *No.* 6, 1001–8 (*Nov.–Dec.*, 1954).

For Pt II, see Abstr. 4329 (1954). Some important properties of the feedback resonance amplifier, especially its response time and noise, are discussed in detail so that its working condition may be deduced. Furthermore, it is shown how the working condition is related to scanning rate and resolving power in automatic absorption measurements. A.

535.33.07

2563. A simple ratio-recording spectrometer. N. H. E. Ahlers and H. P. Freedman. *J. sci. Instrum.*, **32**, *No.* 2, 61–4 (*Feb.*, 1955).

A simple double-beam attachment for a single-beam infrared spectrometer which can be built at little cost is described. No optical modification is needed and a minimum of additional electronic equipment is

required for the existing instrument. The method employed is essentially an alternating beam system used in conjunction with a voltage ratio recorder. The beam splitter consists of a demountable twin cell arranged as a rotating sector wheel positioned in front of the entrance slit of the monochromator and is the only addition to the optical system. A.

535.33.07

2564. Recording vacuum infrared prism-grating spectrometer. K. P. YATES AND R. F. BUHL. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 192–201 (*March*, 1955).

This spectrometer permits the measurement of spectra in the region of 1 to 20 μ. The instrument is evacuable and self-recording. A potassium bromide prism and three permanently installed gratings are employed for standard operation. Prism spectral records are obtained by rotation of the prism only, with a mirror or a grating, which serves as a reflection filter, positioned for specular reflection. A very short time is required for the convenient, semi-automatic change of mode of operation from the recording of prism spectra to that of obtaining grating spectra. During the measurement of grating spectra, the prism, serving as the monochromator, is rotated continuously in suitable spectral synchronization with each respective grating by means of a special cam; this eliminates the usual frequent resetting of the prism. Reliance for accurate wavelength indication is placed upon a specially made fine worm gear, with mechanical amplification to revolution counters, rather than upon a graduated circle. Selsyn mechanisms are utilized throughout for the rotation of the prism and the gratings, the recorder chart drive, the adjustment of slits and the selection of shutter materials. The resulting centralization and simplification of controls permits rapid and convenient scheduled operation of the spectrometer at high or low dispersion as desired. A new and simpler form of the carbon rod infrared source is described. Satisfactory resolving power is attained with this instrument. A.

535.331 : 538.615

2565. Zeeman effect of gold. J. B. GREEN AND H. N. MAXWELL. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 98–102 (*Feb.*, 1955).

The Zeeman effects of Au I and Au II have been investigated in the region of $\lambda\lambda$2400 Å to 6500 Å for a magnetic field strength of about 38 000 gauss. The work of Symons and Daley has been confirmed and somewhat extended for Au I. Unfortunately, most of the Au II patterns were triplets and hence of little value. Some doubt is cast on existing classification of Au II by the persistent appearance of the lines $\lambda\lambda$5354, 5380 and 5427 which come out as strong, well-resolved patterns on the plates, so that g and J values could be found. These lines are members of a multiplet, the transitions occurring between levels $J = 0$, 1, 2 and the level $J = 1$, $g = 1{\cdot}78$. A.

535.331

2566. Relative oscillator strengths for lines of Fe I. J. AARTS, D. HARTING AND C. J. BAKKER. *Physica*, **20**, *No.* 12, 1250–8 (*Dec.*, 1954).

The relative intensities of 80 emission lines in 16 multiplets of iron, in the spectral region λ3800 Å–5300 Å have been measured. Light source was a King furnace with a graphite tube at a temperature of 2800°K as heating element. The spectrograph was a concave grating in Wadsworth mounting, the recording apparatus a photomultiplier with a linear amplifier and tube voltmeter. The f-values derived from the measured intensities are compared with the f-values obtained by R. B. and A. S. King from measurements in absorption. A.

535.331

2567. Hyperfine structure of an infrared line of mercury. J. BLAISE, R. CHABBAL AND P. JACQUINOT. *J. Phys. Radium*, **15**, *No.* 11, 749–52 (*Nov.*, 1954) In French.

The 15 295 Å line was examined by a Fabry–Perot interferometer with PbS detector. Lines due to the even isotopes were well separated, the 3 components of Hg^{199} were identified, but not the separate 8 components of Hg^{201}. The displacement of isotope 202 relatively to 200 is $0{\cdot}1431\ cm^{-1}$. Taking this value as unity the other displacements relative to 200 were calculated as $-0{\cdot}897$ for 198; $-0{\cdot}806$ for 199; $0{\cdot}30$ for 201; $2{\cdot}0$ for 204. The isotopic displacement of the term $d^9s^2p^3P_2$ is $0{\cdot}300\ cm^{-1}$ for 199; $-0{\cdot}332\ cm^{-1}$ for 201. S. T. HENDERSON

535.331

2568. An extension of the analysis of the yttrium spectrum. L. F. H. BOVEY. *Proc. Phys. Soc. [London] A*, **68**, *Pt* 2, 79–80 (*Feb.*, 1955).

Nineteen lines of the yttrium spectrum have been found in the region 9400–11 500 Å and have been assigned to term combinations in the Yt I and Yt II spectra. A.

535.332 : 534.222.2

2569. Spectroscopic studies of highly ionized argon produced by shock waves. H. E. PETSCHEK, P. H. ROSE, H. S. GLICK, A. KANE AND A. KANTROWITZ. *J. appl. Phys.*, **26**, *No.* 1, 83–95 (*Jan.*, 1955).

For the study of high-temperature gas dynamics, shock-tube techniques have been developed earlier to produce shock waves strong enough to heat gases to high and accurately known enthalpy (for argon up to 18 000°K or 40% ionization at equilibrium). This paper reports a study of the visible radiation from the highly luminous argon following strong shock waves. Preliminary spectrograms showed a strong continuum and that the prominent argon lines were broadened and shifted to the red. Correlation of the frequency shifts with theoretical treatments permitted an evaluation of the ion density in the gas. Development of a drum camera spectrograph (film speed 700 ft/sec) in which time effects could be resolved to about 1 μsec indicated that equilibrium ion density was reached rapidly, and provided a rough measurement of the rate of decline of ion density due to cooling. Absolute photoelectric spectrophotometric measurements of the continuum radiation were made and correlated with theoretical expectations. Confirmation of the expected variation of continuum intensity with wavelength and temperature was obtained and an undetermined factor on the theoretical intensity was evaluated. Determinations of the cooling rate of the high-temperature argon from time variation of the continuum intensity, the line shift, and the electrical

conductivity [see Abstr. 2830 (1955)] are in agreement and show that continuum radiation was the dominant heat loss. A.

535.333

2570. The band spectrum of the Au_2-molecule. B. KLEMAN, S. LINDKVIST AND L.-E. SELIN. *Ark. Fys.*, **8**, *Paper* 50, 505–10 (1954).

With gold in a King's furnace an emission spectrum of bands is obtained. The band system, which has its 0, 0 band-head at 5089·28 Å, shows long sequences in the yellow and orange regions. A vibrational analysis of the band system has been carried out. From the experimental conditions under which the spectrum appears and from the relations of the derived band constants to those of the green system of Cu_2, it is concluded that the emitting molecule is Au_2. A.

535.333

2571. Bands of the negative nitrogen system which are displaced towards the red. J. JANIN AND I. EYRAUD. *J. Phys. Radium*, **15**, *No.* 12, 88 S–90 S (*Dec.*, 1954) In French.

The emission spectra of neon–nitrogen mixtures were excited by centimetre waves. The spectra contained the Ne I rays and the weak first- and intense second-positive systems of N, as well as the negative bands which originate in N_2^+. These last in the regions 4700–5600 Å and 3000–4000 Å show a displacement towards red. The bands are classified and the mechanisms of the reactions which take place are considered. A. J. TAYLOR

535.333

2572. The Gaydon bands of N_2. A. E. GRÜN. *Z. Naturforsch.*, **9a**, *No.* 12, 1017–19 (*Dec.*, 1954) In German.

New bands of the green system ($\lambda_{0,0} = 5574{\cdot}4$, 5594·2, 5602·1 Å) have been excited by electron impact. The vibrational constants (cm^{-1}) are $\omega_e'' = 766$, $x_e''\omega_e'' = 12$, $\omega_e' = 923$, $x_e'\omega_e' = 13$.

R. F. BARROW

535.333 : 536.46

2573. On self-absorption and line-shape in the band spectrum of OH in flames. L. HULDT AND E. KNALL. Note in *Naturwissenschaften*, **41**, *No.* 18, 421 (1954) In German.

The absorption by single rotational lines in the ultra-violet spectrum of OH has been measured and found to be significant. Both peak and total absorption coefficients have been evaluated: they may be interpreted to give the ratio of the Doppler broadening to the collision half-width. See also Abstr. 3276 (1954). R. F. BARROW

535.333 : 536.46

2574. The spectrum of the decomposition flame of ozone. A. R. FAIRBAIRN AND A. G. GAYDON. *Trans Faraday Soc.*, **50**, *Pt* 11, 1256–9 (*Nov.*, 1954).

The faint thermal decomposition glow of ozonized oxygen shows a continuous spectrum in the visible which may be associated with the presence of oxides of nitrogen. The explosive decomposition flame of ozone shows the Schumann–Runge system of O_2; excitation is probably thermal rather than chemiluminescent. The results are briefly discussed in relation to the spectra of $CO + O_2$ flames and explosions, the $F_2 + H_2O$ flame and the night sky glow. A.

535.333

2575. New bands in the emission spectrum of acetaldehyde. S. RÉGNIER. Letter in *J. Phys. Radium*, **15**, *No.* 12, 830 (*Dec.*, 1954) In French.

The spectrum obtained in the wavelength range 3750–5000 Å by high-frequency discharge in a gaseous current of acetaldehyde is compared with that obtained using a discharge in a hollow cathode.

G. I. W. LLEWELYN

535.337 : 537.228.5

2576. Theory of the Stark effect in a non-uniform field. The case of atoms other than hydrogen. R. CAYREL. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1601–3 (*Dec.* 8, 1954) In French.

The energy level perturbation due to the Coulomb field of neighbouring ions is calculated to terms of second order in the expansion of the field in powers of the co-ordinates. It is suggested that the effect plays an important role in line broadening in hot stars. J. HUGHES

535.338

2577. Separation of terms of high and low multiplicity in the electronic configurations l_s^m. M. T. ANTUNES. *An. Real. Espan. Fis. Quím.*, **50 (A)**, *No.* 9–10, 175–84 (*Sept.–Oct.*, 1954) In Spanish.

Using a general method, the energy difference, $-kG_1(nl, n's)$ between the term of max. multiplicity and max. value of L, in the l_s^m state, and the term for the same value of L in the l^m state of the ion by addition of an s-electron, is computed. For the first half period, $m \leqslant 2l + 1$, the coeff. k is $(m + 1)$; for the second half, $m > 2l + 1$, k is $(m' + 1)$ where $m' = 4l + 2 - m$. J. J. PHIPPS

535.338.334

2578. Growth curves at high optical densities. L. HULDT. *Z. Naturforsch.*, **9a**, *No.* 12, 1043–7 (*Dec.*, 1954) In German.

Growth curves showing the relation between spectrum line intensity and optical density have hitherto been derived by assuming a combined Doppler and resonance contour. At large distances from the line centre, where the (Lorentz) resonance formula alone should apply, divergences are found between theory and experiment. Calculations on the basis of Lindholm's pressure-broadening formula are shown to give much better agreement.

S. T. HENDERSON

535.34

2579. Measurement of time varying optical absorption. A. V. PHELPS AND J. L. PACK. *Rev. sci. Instrum.*, **26**, *No.* 1, 45–9 (*Jan.*, 1955).

Time-sampling techniques have been applied to the study of optical absorption transients. The method is described in terms of its use for the study of the decay of the concentration of metastable atoms following a pulsed discharge. Light from a capillary source is passed through the discharge tube. The transmitted intensity of one of the spectral lines which is absorbed by the metastable atoms is measured using an interference filter and a gated photomultiplier. The photomultiplier gate occurs at twice the discharge

frequency so that alternate pulses of the photomultiplier output are reduced by absorption. The component of the photomultiplier output at the discharge frequency is proportional to the absorption and can be measured with a narrow band amplifier and synchronous detector. Since the time resolution of the system is determined by the width of the photomultiplier gate, the response of the synchronous detector can be made slow enough to average the absorption signal over many decay periods. Fluctuations in the number of electrons leaving the cathode of the photomultiplier limit the useful sensitivity of the present system to approximately two parts in 10^4. This represents a hundredfold improvement in sensitivity over that available with previous techniques. The results of some studies of helium metastables are presented in order to illustrate the detail which can be obtained with this technique. A.

535.342

2580. Shape of collision-broadened spectral lines. E. P. Gross. *Phys. Rev.*, **97**, *No.* 2, 395–403 (*Jan.* 15, 1955).

Van Vleck and Weisskopf and Fröhlich have derived a microwave line shape by studying the interruption by collisions of the motion of a classical oscillator. They assume that after the instantaneous impact the oscillator variables are distributed according to a Boltzmann distribution appropriate to the value of the applied field at collision. In contrast to the earlier theory of Lorentz, they obtain the correct static polarization. The procedure involves an assumption of very large velocity during collision. This is criticized on the grounds that the duration of collision is short compared to the resonant period and energy-exchanges are of the order of kT. A line-shape formula is derived assuming that the positions are unchanged after impact. Two extreme models are studied. In one, the oscillators have a Maxwellian distribution of velocities after impact; the second is a Brownian motion treatment. The resulting line shape in both cases is that of a friction-damped oscillator. For collision frequency much less than the resonant frequency, the polarization postulated by the above authors is reached as a result of kinematic motion between collisions, and the line shapes agree. However, to obtain equal line widths and peak absorptions, the collision frequency is twice as large for the present theory. For collision frequency comparable to resonant frequency a less distorted line shape results. For testing the theories, experiments on foreign-gas broadening in the microwave region at pressures of the order of an atmosphere are required. Differences between the theories are small for conditions accessible experimentally at present. A.

535.342 : 542

2581. Matrix isolation method for the experimental study of unstable species. E. Whittle, D. A. Dows and G. C. Pimentel. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1493 (*Nov.*, 1954).

The experimental technique described is to spray a gas mixture of just-formed active molecules or radicals and the inert matrix on a cold surface, condensing it, and trapping the unstable species. Tests on various matrix materials with different mole ratios of NO_2 and NH_3 show that the method is effective for mole ratio >100, up to 115°K for methylcyclohexane and to 85°K for CCl_4 and CO_2. Infrared spectra indicated success, e.g. by absence of H-bond shifts. J. HAWGOOD

535.343

2582. Near infrared spectrum of nitric oxide. N. L. Nichols, C. D. Hause and R. H. Noble. *J. chem. Phys.*, **23**, *No.* 1, 57–61 (*Jan.*, 1955).

The $2-0$ and $3-0$ vibration-rotation bands of NO at $2{\cdot}69\,\mu$ and $1{\cdot}8\,\mu$ have been obtained and measured. The envelope of the $4-0$ band at $1{\cdot}36\,\mu$ was obtained. Careful reduction of the data yields the following rotational constants: $B_0 = 1{\cdot}6965\ \text{cm}^{-1}$, $B_2 = 1{\cdot}6631\ \text{cm}^{-1}$, $B_3 = 1{\cdot}6408\ \text{cm}^{-1}$, $B_e = 1{\cdot}7060\ \text{cm}^{-1}$, $\alpha_e = 0{\cdot}0180\ \text{cm}^{-1}$, $I_e = 16{\cdot}404 \times 10^{-40}\ \text{g cm}^2$, $r_e = 1{\cdot}1503 \times 10^{-8}\ \text{cm}$. A.

535.343

2583. Infrared spectral studies of BrF_3 and BrF_5. H. M. Haendler, S. W. Bukata, B. Millard, E. I. Goodman and J. Littman. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1939 (*Nov.*, 1954).

Spectral investigations of these substances are impeded by their strong reactivity: in particular suitable materials for windows are difficult to obtain. CaF_2 was used here as it was found to be the most satisfactory material. Spectra of liquid BrF_3 and BrF_5 were taken from $2{\cdot}5$–$9{\cdot}5\,\mu$. The bands found are tabulated. It seems possible that BrF_3 can form a complex with traces HF similar to that formed by ClF_3. A. J. TAYLOR

535.343

2584. Preliminary study of the spectrum of N_2O in thick layers between $1{\cdot}5$ and $2{\cdot}5\,\mu$. G. Amat, P. Barchewitz and M.-L. Grenier-Besson. *J. Phys. Radium*, **16**, *No.* 1, 16–20 (*Jan.*, 1955) In French.

The vibration-rotation spectrum of nitrous oxide between $1{\cdot}5$ and $2{\cdot}5\,\mu$ was studied. A long optical path was obtained by multiple reflections. As N_2O has several sets of levels with the same symmetry and little differences in energy, various types of multiplet bands occur in the spectrum. All bands observed, including twelve weak bands which were not reported before, are classified. With these data the vibrational constants can be calculated, anharmonic resonance interaction being taken into account. In order to give good agreement with experiment the anharmonic resonance interaction theory needs to be refined. A. J. TAYLOR

535.343

2585. Millimeter wave spectra of AsH_3 and AsD_3. G. S. Blevins, A. W. Jache and W. Gordy. *Phys. Rev.*, **97**, *No.* 3, 684–6 (*Feb.* 1, 1955).

The $J = 0 \rightarrow 1$ rotational transitions of AsH_3 and of AsD_3 have been measured in the one to three millimetre wave region. The B_0 values obtained are, in Mc/s: 112 468·46 for $As^{75}H_3$ and 57 477·15 for $As^{75}D_3$. The observed nuclear quadrupole coupling, eQq, of As^{75} differs for the two species and is $-160{\cdot}1 \pm 0{\cdot}4$ Mc/s for $As^{75}H_3$ and $-165{\cdot}9 \pm 0{\cdot}4$ Mc/s for $As^{75}D_3$. Detectable As^{75} nuclear magnetic interaction was found with the magnetic coupling constant $A = 0{\cdot}33$ Mc/s for AsH_3 and $A = \sim 0{\cdot}07$ Mc/s for AsD_3. From a consideration

of previous microwave work on AsH_2D and a consideration of the differences in the bond angles in normal and deuterated stibine, the bond angle in AsH_3 is assumed to be 91° 50′ and that in AsD_3 to be 91° 31′. These angles with the observed moments of inertia yield the value 1·5192 Å for the As-H length and 1·5145 Å for the As-D length. A.

535.343

2586. Pressure broadening of linear molecules. II. Theory. W. V. Smith, H. A. Lackner and A. B. Volkov. *J. chem. Phys.*, **23**, *No.* 2, 389–96 (*Feb.*, 1955).

For Pt I, see Abstr. 3294 (1954). The large collision diameters for the self-pressure broadening of OCS and BrCN can be explained in terms of P. W. Anderson's general theory as due to the first order dipole-dipole interaction. The temperature dependence of the pressure broadening requires the introduction of other interactions. It is possible to obtain both the magnitude and temperature dependence of the pressure broadening by considering both the first order dipole-dipole and quadrupole-dipole interactions. A.

535.343

2587. Inversion spectrum of ammonia. T. Nishikawa and K. Shimoda. *J. Phys. Soc. Japan*, **10**, *No.* 2, 89–92 (*Feb.*, 1955).

The inversion spectrum of ammonia has been studied in the frequency range between 20 and 12 kMc/s. Twenty-nine lines have been found and 33 lines remeasured. Observed frequencies are compared with the calculated values from Costain's formula and their deviations are discussed. The magnetic hyperfine splittings due to the proton spins for $K = 1$ and $J = 5$, 6, 7, 8, 9 lines have been resolved and measured. The observed splittings are in good agreement with the theoretical results. A.

535.343

2588. Microwave spectrum of $SPCl_3$, theoretical. T. Itoh. *J. Phys. Soc. Japan*, **10**, *No.* 1, 56–9 (*Jan.*, 1955).

The quadrupole hyperfine structure of the $J = 0 \rightarrow 1$ rotational spectrum of $SPCl_3$ is calculated by the method of Bersohn and Mizushima and Itoh. The spectrum of excited vibrational states as well as of the ground state is considered. The theoretical spectrum consists of four groups of lines corresponding to the isotopic species $SPCl_3^{35}$, $SPCl_2^{35}Cl^{37}$, $SPCl^{35}Cl_2^{37}$ and $SPCl_3^{37}$. Asymmetric rotor lines of $SPCl_2^{35}Cl^{37}$ and $SPCl^{35}Cl_2^{37}$, which may appear in the frequency region concerned, are also examined. See also abstract following. A.

535.343

2589. Microwave spectra of $SPCl_3$, experimental. K. Tsukada. *J. Phys. Soc. Japan*, **10**, *No.* 1, 60–4 (*Jan.*, 1955).

See also preceding abstract. The microwave spectra of thiophosphoryl chloride, $SPCl_3$, were studied within the frequency region from 2600 Mc/s to 2900 Mc/s with the cavity spectrometer, of which minimum detectable absorption coefficient was about 5×10^{-9} cm^{-1}. Several absorption lines of the rotational transition of the symmetric and asymmetric top molecules were observed and their temperature effect examined. A.

535.343

2590. Millimeter wave spectra of SbH_3 and SbD_3. A. W. Jache, G. S. Blevins and W. Gordy. *Phys. Rev.*, **97**, *No.* 3, 680–3 (*Feb.* 1, 1955).

The $J = 0 \rightarrow 1$ rotational transitions of normal and deuterated stibine have been measured in the shorter millimetre wave region. The B_0 values obtained are, in Mc/s: 88 031·9 for $Sb^{121}H_3$, 88 015·5 for $Sb^{123}H_3$, 44 693·3 for $Sb^{121}D_3$, and 44 677·1 for $Sb^{123}D_3$. The observed Sb nuclear quadrupole couplings, eQq, differ for the normal and deuterated forms of stibine and are, in Mc/s: for Sb^{121}, 458·7 ± 0·8 in SbH_3, and 465·4 ± 0·8 in SbD_3; for Sb^{123}, 586.0 ± 0·8 in SbH_3, and 592·8 ± 0·8 in SbD_3. These couplings lead to the ratio $Q^{123}/Q^{121} = 1{\cdot}275 \pm 0{\cdot}003$. The Sb nuclear quadrupole moments are estimated to be: $Q^{121} = -0{\cdot}8 \times 10^{-24}$ cm^2, $Q^{123} = -1{\cdot}0 \times 10^{-24}$ cm^2. Significant Sb nuclear magnetic coupling was observed for the normal stibine. In SbH_3 the magnetic coupling constant is found to be 0·33 Mc/s for Sb^{121} and 0·18 Mc/s for Sb^{123}. The ratio of these, $C^{121}/C^{123} = 1{\cdot}84$, is in good agreement with the known ratio of the nuclear g factors, $g^{121}/g^{123} = 1{\cdot}8465$. Slightly different values of the interatomic distances were observed for the normal and deuterated forms. In SbH_3 the Sb–H distance is 1·707 Å and the H–Sb–H angle 91°18′. In SbD_3 the Sb–D distance is 1·702 Å and the D–Sb–D angle 90°56′. A.

535.343

2591. On the absorption spectra of complex ions. I. Y. Tanabe and S. Sugano. *J. Phys. Soc. Japan*, **9**, *No.* 5, 753–66 (*Sept.–Oct.*, 1954).

To explain the origin of both absorption bands and lines of the octahedral normal complex ions in which the central metal ions belong to iron group elements, the crystalline field approximation interpreted in somewhat generalized sense is adopted. For this purpose the calculation of the energy matrix elements for $d^n (n = 1, 2, \ldots, 9)$ electron configuration in cubic field is performed by means of Racah's method. A.

535.343

2592. On the absorption spectra of complex ions. II. Y. Tanabe and S. Sugano. *J. Phys. Soc. Japan*, **9**, *No.* 5, 766–79 (*Sept.–Oct.*, 1954).

The secular determinants obtained in Pt I are solved for the energy levels which are important in the absorption spectra of the normal complex ions, leaving the crystalline field strength as a parameter. The values of B and C (Racah's parameters) there needed are determined from the observed spectra of free ions, or in some cases by extrapolation. The f-values of the transitions which connect the energy levels calculated are estimated and compared with the observed intensities. The difference of the spectral width among absorption bands and lines is also considered, using the energy diagram obtained. Following the assignments thus determined, the calculated positions of lines and bands are in fairly good agreement with the experimental data in divalent ions $[MX_6]^{2+}$ (M = Cr, Mn, Fe, Co, Ni), when the

crystalline field parameter Dq is suitably adjusted. In trivalent ions $[MX_6]^{3+}$ (M = Ti, V, Cr, Mn, Fe), it is necessary besides the adjustment of Dq to use smaller values of B and C than those of the free ions to obtain better agreement with experiments. The values of Dq thus determined are of reasonable magnitude, close to those obtained in other ways. The decrease of B and C compared with those of the free ions might be connected with the recent Stevens suggestion. It is interesting that, though the agreement is poor for $[Co(H_2O)_6]^{3+}$ and $[Co(NH_3)_6]^{3+}$, whose bindings are usually considered covalent, the qualitative explanation of their spectra is found possible in the crystalline field approximation. A.

535.343

2593. Electronic absorption spectra of the dimethylpolyenes. P. NAYLER AND M. C. WHITING. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2091–2 (*Dec.*, 1954).

As no satisfactory experimental data were available to test theoretical results on polyenes, dimethyl polyenes of the form $CH_3(CH{=}CH)_nCH_3$ were prepared and investigated spectrographically. In the curve of n against $\lambda_{n+1} - \lambda_n$ an inflection was found which cannot be removed by adjusting λ_{max} values within experimental errors. As theoretical results indicate no such inflection, the theoretical treatment must be revised. A. J. TAYLOR

535.343

2594. Low-temperature absorption spectra of selected olefins in the farther ultraviolet region. W. J. POTTS, JR. *J. chem. Phys.*, **23**, *No.* 1, 65–73 (*Jan.*, 1955).

A "red shoulder" on the $N \rightarrow V$ absorption curve of olefins, observed at room temperature, but not at low temperature, results from the fact that the potential curves for twist about the double bond in the ground and excited states have slopes of opposite sign. The weaker absorption in the region 40–48 000 cm^{-1} is assigned to the $N \rightarrow T$ absorption on the basis of its analogy to the $N \rightarrow V$ transition in position, extinction coefficient, and oscillator strength. A.

535.343

2595. Low-temperature absorption spectra of benzene, toluene, and para-xylene in the farther ultraviolet region. W. J. POTTS, JR. *J. chem. Phys.*, **23**, *No.* 1, 73–9 (*Jan.*, 1955).

The absorption spectra of the 2100 Å and 1850 Å transitions of benzene, toluene and para-xylene show sharp structure at low temperature. The sharp structure of the 1850 Å transition shows that it is a $\pi - \pi$ type transition, and not a dissociation band. Its correct assignment is ${}^1A_{1g} \rightarrow {}^1E_{1u}$, with analogous assignments in toluene and para-xylene. The 2100 Å transitions of these molecules can be assigned to ${}^1A_{1g} \rightarrow {}^1B_{1u}$ and its analogues, while the 2600 Å transitions are assigned to ${}^1A_{1g} \rightarrow {}^1B_{2u}$. Evidence presented indicates that there is no ${}^1A_{1g} \rightarrow {}^1E_{2g}$ transition in this region of the spectrum. A.

535.343

2596. Absorption of bicycloheptane and bicycloheptene in the vacuum ultraviolet. S. STOKES AND L. W. PICKETT. *J. chem. Phys.*, **23**, *No.* 2, 258–60 (*Feb.*, 1955).

The vacuum ultraviolet absorption spectra of bicycloheptane and bicycloheptene have been investigated in the region from 45 000 to 65 000 cm^{-1}. Two distinct band systems with maxima at 51 125 and 59 715 cm^{-1} were noted in the case of bicycloheptene, each with an oscillator strength of 0·15. The first observed absorption of bicycloheptane was near 55 000 cm^{-1}, while that of the unsaturated hydrocarbon was displaced more than 8000 cm^{-1} towards lower frequencies. In both compounds, sharp narrow bands were superimposed on the continuous absorption. In a study of the photodecomposition, it was shown that cyclopentadiene and ethylene were formed as photodecomposition products of bicycloheptane and also of bicycloheptene. A.

535.343 : 539.132

2597. Sodium and potassium cation dependence of the infrared absorption of COO^-. M. M. STIMSON. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1942–3 (*Nov.*, 1954).

If a number of benzoic acids and their ammonium, sodium and potassium salts are investigated in solid KBr, there is a considerable difference between the spectra of the ammonium and those of the alkali compounds. The symmetric and asymmetric COO^- vibrations of some substituted benzoic acids were investigated. The deformability of the anion by the Na^+ or K^+ ion is indicated by the separation of symmetric and asymmetric vibrations, the former being shifted towards shorter wavelengths, the latter towards longer, under the influence of the potassium ion. The ortho- and para-substituents shift the entire COO^- absorption region farther than meta-substituents, the ortho position being the most influential. A. J. TAYLOR

535.343 : 535.375

2598. Raman and infrared spectral data and tentative assignments for *cis*- and *trans*-diiodoethylene. S. I. MILLER, A. WEBER AND F. F. CLEVELAND. *J. chem. Phys.*, **23**, *No.* 1, 44–9 (*Jan.*, 1955).

Raman displacements, relative intensities and depolarization factors, as well as wave numbers and estimated relative intensities for the infrared absorption bands in the region 400–4000 K (K = kayser = cm^{-1}), have been obtained. Tentative assignments are given for the observed wave numbers and the applicability of the sum and product rules of Mizushima and Bernstein is discussed. A.

535.343

2599. Infrared studies of naphthalene and naphthalene-d_8. W. B. PERSON, G. C. PIMENTEL AND O. SCHNEPP. *J. chem. Phys.*, **23**, *No.* 2, 230–3 (*Feb.*, 1955).

These are reported as follows: (*a*) far infrared studies of solid $C_{10}H_8$ in the region 450 to 130 cm^{-1}, (*b*) studies of single crystals of $C_{10}H_8$ with polarized light in the spectral region 3500–450 cm^{-1} for the *ab* and *bc* planes at normal incidence, (*c*) study of gaseous $C_{10}H_8$ in the spectral region 1350–440 cm^{-1}, (*d*) studies of single crystals of $C_{10}D_8$ with polarized light in the spectral region 3400–500 cm^{-1} for the *ab* plane at normal incidence, (*e*) study of a gaseous $C_{10}D_8$ in the spectral region 1000–700 cm^{-1}. Most likely symmetry assignments for the absorptions of $C_{10}H_8$ and $C_{10}D_8$ are given and some of the bands of $C_{10}D_8$ are correlated with those of $C_{10}H_8$. A.

535.343

2600. The interpretation of the infrared spectrum of a molecular crystal: naphthalene. G. C. Pimentel, A. L. McClellan, W. B. Person and O. Schnepp. *J. chem. Phys.*, **23**, *No.* 2, 234–7 (*Feb.*, 1955).

A critical examination of the oriented gas model is made on the basis of several suggested criteria applied to the infrared studies of solid $C_{10}H_8$ and $C_{10}D_8$. The frequency difference between gas and solid spectra is as high as 1% ν for only a few naphthalene bands. The dichroic band splittings which can be assigned to intermolecular interactions are small, averaging less than 3 cm^{-1}, but with a few well-defined exceptions. A comparison between the observed and predicted dichroic behaviours for those bands whose symmetry classes are known indicates that the dichroism is dominated by the gas phase symmetries of the vibrational modes. The general applicability of the oriented gas model for naphthalene indicates its usefulness in interpreting those solid spectra. On the other hand, the occasional, distinct deviations from the model warn that it is not likely to be useful in studying crystals involving stronger crystal forces (such as hydrogen bonds or ionic forces). A.

535.343 : 535.375

2601. Vibrational spectra and assignment of naphthalene and naphthalene-*d*-8. E. R. Lippincott and E. J. O'Reilly, Jr. *J. chem. Phys.*, **23**, *No.* 2, 238–44 (*Feb.*, 1955).

Infrared and Raman spectra taken of samples of naphthalene-*d*-8 of high deuterium content are reported. These spectra along with spectral data on naphthalene have been used to make an assignment of frequencies to the normal modes of vibration for this molecule. Although this assignment represents a significant contribution towards a correct one and provides good agreement with the experimental thermodynamic data, it still contains a number of tenuous points. A.

535.343 : 535.375.55

2602. Vibrational spectra of cyclobutforene (hexafluorocyclobutene). J. R. Nielsen, M. Z. El-Sabban and M. Alpert. *J. chem. Phys.*, **23**, *No.* 2, 324–8 (*Feb.*, 1955).

The infrared spectrum of gaseous cyclobutforene has been obtained in the region from 2 to 38 μ with the aid of LiF, NaCl, KBr and KRS-5 prisms. The Raman spectrum of the liquid phase has been photographed with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å. With some uncertainties, especially as to symmetry species, all of the twenty-four fundamental vibration frequencies have been assigned, and the spectra have been interpreted in detail. A.

535.343 : 539.132

2603. Vibrational spectra, force constants, and calculated thermodynamic properties of methyltrifluorosilane. R. L. Collins and J. R. Nielsen. *J. chem. Phys.*, **23**, *No.* 2, 351–6 (*Feb.*, 1955).

The infrared spectrum of gaseous $H_3C–SiF_3$ has been obtained in the region 2·5–36 μ. The Raman spectrum of the liquid phase under pressure has been photographed with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4358 Å, and qualitative polarization measurements have been made. The eleven active fundamental vibration frequencies have been assigned, and a tentative value has been assigned to the inactive fundamental. A normal co-ordinate analysis has been made, and thermodynamic properties have been calculated. A.

535.343

2604. Infrared spectrum of solid *n*-octane-1,1,1,8,8,8-d_6. G. C. Pimentel and W. A. Klemperer. *J. chem. Phys.*, **23**, *No.* 2, 376–8 (*Feb.*, 1955).

This has been obtained at liquid nitrogen temperature from 1500 cm^{-1} to 600 cm^{-1}. An assignment of the vibrations into methyl and methylene motions is made. A.

535.343

2605. Infrared absorption spectra observed at great dilutions. J. C. Pariaud and P. Archinard. *J. Phys. Radium*, **15**, *No.* 12, 83 S–85 S (*Dec.*, 1954) In French.

The intensity of the methanol infrared absorption band at 9·68 μ has been determined for gaseous mixtures of methanol (at partial pressures in the range 1 to 90 mm Hg) and acetone (partial pressures 5·5 to 139 mm). The results are figuratively represented and interpreted in terms of the different types of interaction between the molecules at different relative concentrations. G. I. W. Llewelyn

535.343 : 539.132

Infrared spectrum and hydrogen bonding of pyrrole. *See Abstr.* 2945

535.343

2606. The microwave spectrum of ethyl fluoride. J. Kraitchman and B. P. Dailey. *J. chem. Phys.*, **23**, *No.* 1, 184–91 (*Jan.*, 1955).

This has been investigated in the region from 17 to 38 kMc/s. The values of the rotational constants of the molecule obtained from the analysis of the spectrum are: $A = 36\,070{\cdot}30 \pm 0{\cdot}10$ Mc/s, $B = 9364{\cdot}54 \pm 0{\cdot}10$ Mc/s, and $C = 8199{\cdot}74 \pm 0{\cdot}10$ Mc/s. The following structural parameters have been fitted to these rotational constants: $r_{CH} = 1{\cdot}091$ Å, $r_{CC} = 1{\cdot}540$ Å, $r_{CF} = 1{\cdot}375$ Å, and tetrahedral bond angles. The dipole moment components along the principal axes of the molecule are $\mu_A = 1{\cdot}69D$ and $\mu_B = 1{\cdot}00D$; the total dipole moment, $\mu = 1{\cdot}96 \pm 0{\cdot}03D$, is oriented at an angle of 64° with respect to the C–C bond axis, or approximately 7° from the C–F bond axis. The barrier height for internal rotation is 1490 ± 50 cm^{-1} (4260 cal/mole). A.

535.343 : 539.132

2607. Microwave spectrum of methylamine. K. Shimoda, T. Nishikawa and T. Itoh. *J. Phys. Soc. Japan*, **9**, *No.* 6, 974–91 (*Nov.–Dec.*, 1954).

This has been studied in the frequency range between 7 and 30 kMc/s. More than two hundred lines and their Stark effects have been measured. These lines are divided into three kinds: (1) $\Delta J = 0$, $\Delta K = \pm 1$, (2) $\Delta J = \pm 1$, $\Delta K = \mp 1$, and (3) $\Delta J = 0$, $\Delta K = 0$. Lines of $\Delta J = 0$ and $\Delta K = \pm 1$ form seven well-defined series, p_1, p_2, q_1, q_2, r_1, r_2, and s_1. Among them, p-series lines show first-order Stark effects and the others show second-order Stark effects. These series have been assigned and from this the

height of the potential barrier for the hindered internal rotation has been determined to be about 680 cm^{-1}. Inversion doubling and its effect on the over-all and hindered rotations are studied. Lines belonging to the classes (2) and (3) are also analysed. A.

535.345

2608. *K* band in additively colored KCl. H. W. Etzel and F. E. Geiger, Jr. Letter in *Phys. Rev.*, **96**, *No.* 1, 225–6 (*Oct.* 1, 1954).

Experimental absorption band studies indicate that the *K*-band is not due to $1s \rightarrow np$ transitions in the *F*-centre but is a "non-normal" *F*-centre. G. F. J. Garlick

535.345 : 535.371 : 539.11

2609. Optical properties of cadmium sulfide in glass. G. Kuwabara. *J. Phys. Soc. Japan*, **9**, *No.* 6, 992–6 (*Nov.–Dec.*, 1954).

The optical properties of glasses containing CdS were measured for a few specimens after different heat treatment. The absorption edge shifts towards longer wavelengths as the reheating progresses. However, its shape and temperature-dependence are similar to those of the single crystal. The maximum wavelengths of luminescent and excitation spectra also shift with the absorption edge and a linear relation exists between those wave-numbers. From these results, it may be inferred that the optical properties of these glasses are due to CdS crystals, and their changes show that the energy gap between the filled and the conduction band in the crystals decreases with reheating; this is probably caused by the change in the lattice constants of the crystal. A.

535.345 : 537.312.5

2610. Relation of antimony transmission and the photoelectric yield of Cs–Sb. M. Rome. *J. appl. Phys.*, **26**, *No.* 2, 166–9 (*Feb.*, 1955).

The relation of transmission of thin films of antimony as a function of thickness expressed in μg per cm^2 has been determined for blue, red, and white illumination. An abrupt change in optical properties of the antimony layer has been noted at the phase change. The transition occurs at a transmission of approximately 30%. Photosurfaces have been prepared by activating the deposited antimony films with caesium. The photoelectric yield for both regular and reverse illumination has been determined for different antimony thicknesses. For reverse illumination the peak response occurs between 5·5 and 6·0 μg per cm^2 of antimony. Expressing the photoresponse for reverse illumination of green light with decreasing transmission of the original antimony layer for blue, white, and red light shows peaks at 82, 88, and 92%, respectively. The transmission of the photosurface, which is substantially independent of processing or photoelectric efficiency of the surface, is given for blue, green, and white light. A.

535.345 : 538.615

2611. On the influence of the Zeeman effect on the absorption of light. D. Pejnović and B. Marković. *Period. math.-phys. astron.* [*Zagreb*] **8**, *No.* 3, 213–27 (1953) In Serbo-Croat. Summary (4 *pp.*) in German.

Describes an arrangement for observing resonance radiation in Na vapour at $T = 300°C$, and the observation of light from sodium flame after it has passed through another sodium flame placed in a magnetic field (H); when the field is on, the absorption is reduced due to the splitting of the resonance lines; the reduction is greatest when viewing $\perp$ to H through a Nicol transmitting light with electric vector $\perp$ to H, since the displacement of the components is greatest. The effects are illustrated by photographs. Such experiments "show the Zeeman effect without use of spectroscopic apparatus." G. F. Lothian

535.345 : 539.234

2612. On the optical absorption of thin BaO film in the ultraviolet region. K. Takazawa and T. Tomotika. *J. Phys. Soc. Japan*, **9**, *No.* 6, 996–1000 (*Nov.–Dec.*, 1954).

By measuring the optical transmittance of evaporated BaO film in vacuum, it has been found that the threshold for absorption occurs at 3200 Å and the second rapid rise in absorption begins at 2500 Å approximately. Two absorption bands have been observed in the region ranging from 2500 Å to 3200 Å: one has a maximum at 2800 Å and the other has a maximum at about 3000 Å. The latter absorption band is new and has not been observed so far by the method of optical transmittance, though its presence has been suggested by the photoconduction of a BaO single crystal. The influence of oxygen vapour upon the absorption bands has also been investigated, and it has been observed that when a thin BaO film was exposed to oxygen, the absorption bands in the region 2500 Å–3200 Å vanished suddenly and the film became transparent in the region of wavelengths longer than 2500 Å. A.

535.345 : 539.234

2613. Structure in optical absorption of barium oxide films. R. J. Zollweg. *Phys. Rev.*, **97**, *No.* 2, 288–90 (*Jan.* 15, 1955).

Measurements of the optical absorption of BaO films at temperatures between 15° K and 370° C are reported. Four absorption peaks between 3·8 eV and 4·5 eV are found for measurements at liquid nitrogen temperature or below. At least the two strongest peaks are thought to be caused by exciton absorption. The sharpness of the structure is found to depend upon substrate temperature during evaporation and upon the temperature at which the optical measurements are made. A.

535.345 : 548.7

2614. Optical behaviour of multi-domain single crystal of $BaTiO_3$ in dependence on temperature. T. Horie, K. Kawabe and S. Sawada. *J. Phys. Soc. Japan*, **9**, *No.* 5, 823–5 (*Sept.–Oct.*, 1954).

Apparent absorption edge, transmissivity and true characteristic absorption edge have been measured, covering the three transition points, −70°C, 5°C and 120°C. The true characteristic absorption edge shifts linearly, with the temperature coefficient quite close to that so far known in ionic crystals. Both the apparent absorption edge and the transmissivity exhibit quite steep hysteresis curves especially near −70°C. It may be due to the domain structure which is expected to develop when the lattice changes from orthorhombic to rhombohedral near this transition point. A.

535.345 : 548.7

2615. The absorption spectrum of $NaNO_3$ exposed to ionizing radiation. P. PRINGSHEIM. *J. chem. Phys.*, **23**, *No.* 2, 369–75 (*Feb.*, 1955).

The changes produced by ionizing radiation in the absorption spectrum of $NaNO_3$ crystals are in the main caused by two effects: the conversion of NO_3^- ions into NO_2^- ions with an absorption band, which has its peak at 345 mμ and shows a characteristic structure when observed at low temperature; and the production of colour centres with a continuous absorption band with peak at 335 mμ. The formation of the colour centres is assumed to be connected with the presence in the lattice of NO_2^- ions, although no precise model can be proposed for these centres. The colour-centre band can be bleached by ultraviolet light even at −190°C; at room temperature it is partially destroyed by the ionizing radiation which is able to produce the centres, while this is not the case with respect to the NO_2^- ions. Therefore the NO_2^- band is relatively much stronger in crystals exposed to the ionizing radiation at higher temperatures, for instance in the pile, while in crystals X-rayed at −190°C the colour-centre band prevails. A.

535.347

2616. Measurements on ultra-violet dichroism. J. C. WARD. *Proc. Roy. Soc. A*, **228**, 205–19 (*Feb.* 22, 1955).

The dichroism of ultraviolet absorption bands of thin single crystals of some organic compounds has been measured, and the results used to determine the direction of the molecular transition moments of the peptide group and of substituted phenyl groups. Some of the theory of the optics of absorbing crystals has been presented in a form which is useful in interpreting dichroism measurements in terms of crystal and molecular structure. A.

535.35 : 539.181

2617. Optical methods of atomic orientation and their applications. A. KASTLER. *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 10, 853–63 (*Oct.*, 1954) In French.

Ninth Holweck Lecture. Absorption of polarized radiation by atoms in a magnetic field gives rise to only some of the Zeeman sub-levels of an excited state. Resonant or fluorescent radiation will in general be polarized and the radiating atoms will yield a selective distribution among the Zeeman levels of the ground state. Such an "optical pump" consisting of a beam of Na atoms illuminated with *D* light gave 30% excess of the $m_J = +\frac{1}{2}$ state, determined by a differential photoelectric measurement of scattered resonance radiation. Such beams of oriented atoms have been used in magnetic resonance experiments. When there is coupling with nuclear spin the method gives beams with oriented nuclei and it is proposed to measure the γ-ray distribution of such beams of Na^{22}. The possibility of producing polarized photo-electrons is considered. G. F. LOTHIAN

535.371

2618. The storage of energy in some activated alkali halide phosphors. H. O. ALBRECHT AND C. E. MANDEVILLE. *J. Franklin Inst.*, **257**, *No.* 5, 353–68 (*May*, 1954).

The phosphorescent emission of thallium activated NaCl and KCl has been investigated at 25°C, using as primary excitants α-particles and ultraviolet light. The energy storage properties of X-ray irradiated NaCl–Tl, KCl–Tl, NaCl–Ag, and KCl–Ag have been compared, and the photostimulated ultraviolet emission of NaCl–Ag has been determined as a function of the silver concentration. Some dosimetric aspects of the data are discussed. A.

535.371

2619. The infra-red luminescence of solid halogens. M. J. DUMBLETON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 1, 53–4 (*Jan.*, 1955).

The halogens Cl, Br and I in solid form show infrared emission bands with peaks at 1·0, 1·15 and 1·5 μ respectively when excited in the regions 0·4, 0·55 and 0·7 μ respectively. Similar behaviour is shown by the interhalogen compounds ICl and IBr.

G. F. J. GARLICK

535.371

2620. Photostimulated emission of some activated alkali halide phosphors. C. E. MANDEVILLE AND H. O. ALBRECHT. *Phys. Rev.*, **97**, *No.* 2, 347–51 (*Jan.* 15, 1955).

The intensity of the photostimulated ultraviolet emission of X-ray excited phosphors of NaCl–Tl, KCl–Tl, NaCl–Ag, and KCl–Ag has been measured as a function of the wavelength of the incident light. The results indicate that, in the first thirty days following excitation at least, *F*-centres are primarily responsible for the storage of energy. Thus, the storage properties depend upon the nature of the host material, rather than upon the intentionally added activator. Evidence is also presented which seems to indicate the presence of a deep trap associated with the silver ions of KCl–Ag which has a period of decay comparable to that of the *F*-centres. Excitation, storage, and all measurements were carried out at 22°C. Polycrystalline materials were used throughout the investigation. A.

535.371

2621. Enhancement of fluorescence in solutions under high-energy irradiation. M. FURST AND H. KALLMANN. *Phys. Rev.*, **97**, *No.* 3, 583–7 (*Feb.* 1, 1955).

Organic solutions with poor high-energy-induced fluorescence can often be made much more efficient by introducing large concentrations of substances such as naphthalene and some related compounds. The naphthalene can be considered as an intermediate solvent; the energy originally mainly absorbed in the less effective solvent goes over to the naphthalene from which it then proceeds to the fluorescent solute. Naphthalene is considerably more effective as such an intermediate solvent than any other of the known efficient solvents, e.g. xylene. It is shown that the particular effectiveness of naphthalene stems from two causes: first, the energy transfer from the "poor" solvent to naphthalene is faster than to other substances; secondly, the excited naphthalene molecule is often quenched less than, e.g. xylene by quenching atoms present in the solution. These results are applied to the enhancement of the high-energy-induced fluorescence of solutions containing various elements even as heavy as bismuth. A.

535.371

2622. Decay of phosphorescence with activators and traps arising from the same impurity in different valency states. K. LEHOVEC. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 219–22 (*March*, 1955).

The decay of phosphorescence which arises from the presence of conduction electrons, activators and traps is investigated, assuming that the same impurities may either lose an electron, leaving an empty activator, or gain an electron, becoming a filled trap. In particular, the case of negligible contribution by conduction to space charge is treated. A.

535.372 : 548.7

2623. The edge emission of ZnS, CdS and ZnO and its relation to the lattice vibrations of these solids. F. A. KRÖGER AND H. J. G. MEYER. *Physica*, **20**, *No.* 12, 1149–55 (*Dec.*, 1954).

It is shown that the vibrational structure appearing in the luminescent emission close to the fundamental absorption bands of ZnS, CdS and ZnO corresponds to the frequency of the longitudinal lattice vibrations of the optical branch, either alone or in combination with the transverse vibrations of this branch. This proves that the edge emission is a property of the pure, unperturbed lattice. In connection with observations by Klick as well as from fundamental theoretical reasoning it is concluded that the fluorescence is due to excitons. Weak bands, appearing at shorter wavelengths, are attributed to band-band transitions or to higher exciton states. The appearance of double peaks in the infrared absorption spectrum of ZnO and BeO is explained by a process which involves phonons of the optical and acoustical branch according to a theory given by Born and Blackman. A.

535.375.5

2624. Variation of Raman frequencies with the temperature and quadrupolar resonance. B. DREYFUS AND D. DAUTREPPE. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1618–20 (*Dec.* 8, 1954) In French.

A theoretical explanation is given of the experimental curves for the thermal variation of the quadrupolar resonance frequency for *p*-dichlorobenzene and *p*-dibromobenzene at temperatures up to 300°K. The discrepancy between these curves and the theoretical curves of Bayer [Abstr. 1170 (1952)] is interpreted. G. I. W. LLEWELYN

535.375.55

2625. Depolarization ratios of the Raman bands of thionyl chloride. G. ALLEN AND C. A. MCDOWELL. Letter in *J. chem. Phys.*, **23**, *No.* 1, 209–10 (*Jan.*, 1955).

Investigation of the Raman spectrum of $SOCl_2$ using a photoelectrically recording spectrometer shows that the 194 cm^{-1} band is polarized (corrected $\rho = 0{\cdot}53$). It is thus concluded that the molecule is nonplanar and belongs to the point group C_s.

G. I. W. LLEWELYN

535.376

2626. Remarks on the mechanism of electroluminescence. R. GOFFAUX. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 5, 808–14 (1954) In French.

It is suggested that the high-intensity electric fields producing electroluminescence in phosphors result in an increase of conduction-electron temperature over that of the lattice and lead to multiplication of carriers. The theory developed is applied to the dependence of emission on field frequency.

G. F. J. GARLICK

535.376

2627. Modifications of electroluminescence due to temperature. J. MATTLER. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1616–18 (*Dec.* 8, 1954) In French.

535.39

2628. Optical constants of metals in the infra-red—principles of measurement. J. R. BEATTIE AND G. K. T. CONN. *Phil. Mag.*, **46**, 222–34 (*Feb.*, 1955).

In measuring the optical constants of an absorbing medium two pieces of information are required and may be obtained by examining the reflection of plane-polarized light at the principal angle of incidence. Since this angle is very close to 90° for metals in the infrared, the value of measurements at smaller angles is examined. It is shown that there are serious disadvantages if reflecting coefficients only, such as R_p^2, R_s^2 or the ratio ρ^2, are measured. The ratio ρ of the reflecting coefficients of the *p*- and *s*-components and the relative phase difference Δ provide the most suitable parameters to measure at angles of incidence less than the principal angle. These are directly related to the modulus and the argument of the complex refractive index $n - ik$. Calculation of optical constants from the measurements is always tedious. A chart has been prepared whereby the real and imaginary parts of the dielectric constant may be obtained from ρ and Δ with an accuracy of 1%; the preparation and use of these graphs is discussed. Illustrations are provided by quoting experimental results from 2 μ to 12 μ obtained with nickel, copper, silver, aluminium, mercury and antimony. A.

535.39

2629. Optical constants of metals in the infra-red—experimental methods. J. R. BEATTIE. *Phil. Mag.*, **46**, 235–45 (*Feb.*, 1955).

For metals the principal angle of incidence in the infrared is near 90° and it has been shown that the real and imaginary parts of the dielectric constant are best obtained by measuring ρ and Δ; ρ is the ratio of the reflectivities of the *p*- and *s*-components and Δ the relative phase difference. ρ and Δ may be obtained without using birefringent materials by measuring two ratios of intensities, a technique which provides a cross-check. The experimental methods and arrangements developed to measure a number of metals in the spectral range 2 μ to 12 μ are described; this range can be extended where necessary. Use of multiple reflections is discussed and errors are examined. Measurements are reported of evaporated aluminium mirrors since these are frequently used. A.

535.39

2630. The theory of the reflectivity of metals. R. WOLFE. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 121–7 (*Feb.*, 1955).

The reflectivity of an ideal metal is calculated for infrared light by a quantum-mechanical method. It is assumed that the conduction electrons in the metal absorb light by a photoelectric process which takes place near the surface, that these electrons behave as if they are free and that the light within the metal

decays according to the formula given by the classical skin effect. Two types of wave-functions are assumed for the electrons, corresponding to the assumptions of specular and diffuse reflection of the electrons at the surface of the metal. The absorptivity ($1 - R$, where R is the reflectivity) in the case of specular electron reflection is found to be $A_S = (Ne^2/2\pi mv^2)v_0^3/c^3$; for diffuse reflection, $A_D = \frac{3}{4}v_0/c$. These results are the same as those obtained by Holstein and by Dingle using different methods which are essentially classical. Since A_D gives the better agreement with experiment, it is concluded that the "diffuse reflection" wave-functions are a better approximation to the exact electronic wave-functions than the "specular reflection" wave-functions which have been used in previous work on the photoelectric effect and reflectivity. A.

535.39 : 537.311.31 : 539.23

2631. The evaluation and analysis of optical and electrical constants of thin films as functions of reflectance and transmission data by electronic digital computation. L. HARRIS AND A. L. LOEB. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 179–88 (*March*, 1955).

Whirlwind I, an electronic digital computer at M.I.T., has been used to calculate accurately the optical and electrical constants of thin metal films on nonabsorbing backings and of aluminium oxide films, and to check approximate relations which may be conveniently used in the absence of a digital computer. The conductance per square of film is found to be the principal physical property determining the behaviour of conducting films towards incident infrared radiation. The variation with wavelength is related to the finite relaxation time of the free electrons and to imperfections in the films acting as condensers. In the visible wavelength region the two sets of optical constants were evaluated for different thicknesses of gold deposits and compared to optical constants previously reported. A.

535.39 : 539.23

2632. The optical properties of thin oxide films on tantalum. A. CHARLESBY AND J. J. POLLING. *Proc. Roy. Soc. A*, **227**, 434–47 (*Feb.* 8, 1955).

The iridescent colours produced at the surface of anodically oxidized tantalum have been studied spectrophotometrically. These colours result from interference, the intensity of the reflected light varying between certain maximum and minimum values according to the wavelength. From measurements of the wavelengths at which the minima occur, from 2600 to 8500 Å, the refractive index and its variation with wavelength are deduced. Values are 2·84 at 3000 Å and 2·42 at 8000 Å. The phase change at the metallic surface was also deduced, values being $0{\cdot}2\pi$ radian at 2700 Å and $0{\cdot}8\pi$ radian at 8000 Å. The thickness of the anodically-formed films has been found to be 16·0 Å/V. A.

535.39 : 539.23

2633. Optical constants of thin-film materials. G. D. SCOTT. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 176–9 (*March*, 1955).

A review of the basic optical properties of single-layer thin films, both metal and dielectric, with particular reference to their optical constants. Differences between the optical constants of materials in bulk and in thin films are discussed. In the case of aggregated metal films the Garnett theory gives a satisfactory interpretation of these differences. A.

535.414

2634. Refractive index determination in the interference microscope of CdS for example. G. SCHULZ. Note in *Naturwissenschaften*, **41**, *No.* 22, 525 (1954) In German.

An interference system, similar to the Mach–Zehnder interferometer but viewed with a microscope, allows a double fringe system to be seen covering a micro-crystal. The thickness and refractive index can then be calculated. Photographs showing a CdS crystal are given, and the indices calculated are shown to agree with those obtained by other methods.

R. W. FISH

535.415 : 535.543

2635. Further study of polarization and interference colors. H. KUBOTA AND T. OSE. *J. Opt. Soc. Amer.*, **45**, *No.* 5, 89–97 (*Feb.*, 1955).

Colorimetric analysis of the colour of light passed through a birefringent crystal placed between Nicol prisms is treated more generally than hitherto discussed, by adding an achromatic retardation. It is found that, by proper choice of the achromatic retardation, the colour change with respect to the change of birefringence becomes very sensitive and this is called "hypersensitive (polarization) colour." The case when the crystal has the power of rotating the plane of polarization, which can be treated in the same way, is also shown. Then the colour of thin layers of dielectrics on a metallic surface is analysed. This can be treated as an extension of the cases of polarization colour. As it is difficult to give a general solution, some special cases (so-called cases of "white metal") are given and the colour of the reflected light is calculated and plotted on CIE chromaticity diagram. A.

535.417

2636. Recent improvements in interferometry. V. RONCHI. *Atti Fond. Ronchi*, **9**, *No.* 2, 89–109 (*March–April*, 1954) In Italian.

The author gives a general review of the use of interference as a means of measurement and surface examination. Recent work increasing the precision and sensitivity of the method is discussed. R. W. FISH

535.417

2637. An improved mirror mounting for optical interferometers. T. F. W. EMBLETON. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 152–3 (*March*, 1955).

A mirror mounting is described which enables the rotational adjustments of the optical surface to be made about axes passing through the centre of that surface. This feature resulted in considerable simplification of the adjustment of a Mach–Zehnder interferometer in which it was used. Some special properties of the mounting are mentioned. A.

535.417 : 531.711

2638. Problem of phase variation with wavelength in dielectric films. Extension of interferometric standards into the infrared. D. H. RANK AND H. E. BENNETT. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 69–73 (*Feb.*, 1955).

A purely interferometric method is suggested by which known standard wavelengths in the visible part

of the spectrum are used to determine new wavelength standards in the infrared. The application of the method of exact fractions to measurements made using a Fabry–Perot interferometer whose plates are coated with highly reflecting dielectric films is discussed. It is shown that the large phase corrections introduced by these films may be reduced to differential corrections if relative wavelength measurements are made near wavelengths for which the phase change on reflection is π. A method of experimentally determining both the differential correction and wavelengths at which the phase change of π occurs is suggested. A.

535.421

2639. Diffraction gratings in immersion. E. Hulthén and H. Neuhaus. *Ark. Fys.*, **8**, *Paper* 34, 343–53 (1954).

The immersion principle has been tested in two cases. In the first case a fine-ruled grating was brought into optical contact with a glass plate through an immersion-oil of high refracting index. A characteristic intensity shift of the blaze order into higher orders in the spectrum was observed. In the second case the principle was applied to a coarse-ruled échelle grating by combining it with a flint prism. The considerable increase of the resolving power and the dispersion of this new instrument is demonstrated. Strioscopic methods have been used in tracing optical irregularities in gratings and prisms, and the importance of a coherent illumination of the spectroscope slit is stressed. The application of the immersion principle has been restricted to plane gratings. A.

535.421

2640. On the origin of unsymmetrical Rowland ghosts in optical gratings. E. Djurle. *Ark. Fys.*, **8**, *Paper* 38, 383–9 (1954).

The ordinary theory of Rowland ghosts shows that they should be symmetrical in intensity, but it is nevertheless a well-known fact that they are sometimes unsymmetrical. A study of the way they are built up, according to diffraction theory, shows that their asymmetry is explained by certain anomalies present in the phase structure of the grating. Such anomalies have been found in gratings when examined by the phase-contrast method. A.

535.434

2641. Light scattering in soap solvent systems. Depolarisation factors of transversely scattered light in sodium oleate-xylene systems during and after gel-formation. V. Sundaram. *Proc. Indian Acad. Sci. A*, **40**, *No.* 4, 176–83 (*Oct.*, 1954).

The depolarization factors ρ_u, ρ_v and ρ_h of the light transversely scattered from sodium oleate-xylene systems have been measured during and after gel-formation. It was observed that the particles in these systems increase in size and anisotropy during and after gel-formation. The observed results are explained on the basis of the existing theory of the formation of soap gels in organic solvents. The size of particles in these gels does not seem to depend on the concentrations of the gel-forming systems. A.

535.434

2642. The determination of particle size and refractive index near the turbidity maximum in monodisperse suspensions of spherical particles. W. Heller. *J. chem. Phys.*, **23**, *No.* 2, 342–3 (*Feb.*, 1955).

Theoretical values on the specific turbidity of colloidal spheres within the range of diameters of 1 to 2 μ are given. It is shown how an unambiguous particle size can be determined with this range in spite of a turbidity maximum. The latter can be determined for almost any refractive index by means of an empirical equation. An alternate turbidity maximum can be used for determining the refractive index of the light-scattering material provided the diameter is known. A.

535.435

2643. On the experimental study of macromolecular solutions by scattering of light. III. Experimental determination of Rayleigh's ratio. Application to benzene. S. Guinand and J. Tonnelat. *J. Chim. phys.*, **51**, *No.* 10, 539–47 (*Oct.*, 1954) In French.

For Pt II, see Abstr. 10096 (1954). Discusses the different methods which have been used to determine Rayleigh's ratio, and outlines the corrections required for such factors as beam divergence, refraction at walls of container, etc. The results of 12 determinations by different methods are quoted, and the range is from 27×10^{-6} to $48{\cdot}5\times10^{-6}$ for wavelength 4358 Å at 25°c. Some of these values have been adjusted to these conditions. The authors give reasons for accepting the low values obtained rather than the higher ones, but give their opinion that it is at present impossible to determine the absolute values of molecular weights by scattering methods. N. Corcoran

535.55

2644. Photoelastic studies of optically active crystals. $NaClO_3$ and $NaBrO_3$. T. S. Narasimhamurty. *Proc. Indian Acad. Sci. A*, **40**, *No.* 4, 167–75 (*Oct.*, 1954).

Double refraction and optical activity were studied by employing the Rayleigh Compensator and the photoelastic constants of $NaClO_3$ have been redetermined, confirming the results obtained by Ramachandran and Chandrasekharan (1951). The photoelastic constants of $NaBrO_3$, another *T*-class crystal, have been determined for the first time, employing the Rayleigh Compensator and also the elliptic analyser previously employed by Ramachandran and Chandrasekharan for studying $NaClO_3$; and the results confirm the theoretical prediction of Bhagavantam (1942). The values for $NaBrO_3$ are as follows: $p_{11} = 0{\cdot}185$; $p_{12} = 0{\cdot}218$; $p_{13} = 0{\cdot}213$; $p_{44} = -0{\cdot}0139$ and $q_{11} = 1{\cdot}63\times10^{-13}$; $q_{12} = 2{\cdot}58\times10^{-13}$; $q_{13} = 2{\cdot}45\times10^{-13}$; $q_{44} = -0{\cdot}93\times10^{-13}$ (all in units of cm^2. $dyne^{-1}$). A.

535.55

2645. A magneto-optic method for the determination of piezo-optic coefficients. S. Ramaseshan. *Proc. Indian Acad. Sci. A*, **40**, *No.* 4, 184–8 (*Oct.*, 1954).

A simple method for the measurement of the relative retardation produced on stressing an isotropic solid is described. It is based on the determination of the true and apparent magneto-optic rotation of the isotropic solid in the unstressed and the stressed states. The method is found to be useful in the measurement of the dispersion of the piezo-optic coefficients with wavelength. A.

535.55

2646. Optical method of measurement and separation of the constraints in plane elasticity. P. ACLOQUE. *C.R. Acad. Sci.* [*Paris*] **239,** *No.* 21, 1350–2 (*Nov.* 22, 1954) In French.

The theory is given of a method, useful for photoelastic studies, which enables the separate values of the stresses to be obtained by a single setting in each of the principal planes of the sample. The method utilizes light incident in a direction inclined to the normal to the faces of the sample and polarized at 45° to the plane of incidence. H. G. JERRARD

535.557 : 539.216.1

Orientation and double refraction in polymers. *See Abstr.* 3158–9

535.64

2647. Ostwald's system of pigments in relation to the trichromatic theory of Young and Helmholtz. H. HÖNL. *Naturwissenschaften,* **41,** *No.* 21, 487–94 (1954) In German.

This valuable theoretical paper gives a detailed description of Ostwald's system and the physicists' criticism levelled against it. An account is also given of the difference between this system and the trichromatic theory. The paper is all the more valuable as its points can be generalized to apply also to other colour systems which lay claim to being fundamental. See also abstract following. R. A. WEALE

535.64

2648. Ostwald's system of pigments in relation to the trichromatic theory of Young and Helmholtz. H. HÖNL. *Naturwissenschaften,* **41,** *No.* 22, 520–4 (1954) In German.

This paper diagnoses and removes the points of incompatibility between the two systems. It concludes with an instructive discussion of other theories of colour vision but references to British work on the subject are lacking. 4 figs. 24 refs. R. A. WEALE

535.65

2649. Colorimetric calibration of colorant systems. H. R. DAVIDSON AND H. HEMMENDINGER. *J. Opt. Soc. Amer.,* **45,** *No.* 3, 216–19 (*March,* 1955).

If a set of colorants is to be used in making large numbers of specified colours, a calibration of the relationship between colorant composition and colorimetric specifications provides a very efficient means of procedure. In the case discussed, samples exemplifying the Munsell renotation were painted from such a calibration. A set of six chromatic paints plus black and white was first chosen on the basis of colour gamut, fastness and other physical properties. Since mixtures of two chromatic paints plus black and white provide three degrees of freedom, such mixtures are sufficient to obtain any colour within the gamut of the chosen paints. The required calibration, therefore, must relate the ratios of chromatic paints, black, and white to colorimetric specifications within the gamut. This calibration was made by painting samples of a constant ratio type colorant mixture system, determining the C.I.E. and Munsell specifications, then establishing graphs of the relation between colorant ratios and colour co-ordinates. The mixture formulae for the desired Munsell renotation samples were then read from these graphs. A.

535.65

2650. The official German standard color chart. M. RICHTER. *J. Opt. Soc. Amer.,* **45,** *No.* 3, 223–6 (*March,* 1955).

This chart (DIN-Farbenkarte) is intended as a technical resource for practical specification of colour and is carried out with the purpose of developing scales as uniformly as possible for all parts of the colour space. In this system the colours are arranged according to hue, saturation, and darkness degree, each of them being divided by uniform psychological steps. A specification of colour tolerances by means of these scales is suggested. In its standard form the DIN-Farbenkarte is realized by a set of gelatine filters, where the different darkness degrees are obtainable by optical methods. A.

535.7

Physiological optics. Vision. *See under* "Medical science. Human physiology." Decimal classification 612.84

535.81 : 539.23

2651. Some applications of single and multilayer films. O. S. HEAVENS. *Lab. Pract.,* **3,** *No.* 11, 447–50 (*Nov.,* 1954).

An account of recent applications of thin metallic films in optical instruments. Their use in the blooming of lenses and the protection of the metal films by SiO or anodization are explained. Metal neutral density filters and aspherization of surfaces are discussed. R. A. WEALE

535.822.17

2652. Some experiments on phase-contrast microscopy. K. RÄNTSCH. *Optica Acta,* **1,** *No.* 3, 141–51 (*Dec.,* 1954) In German.

To obtain high contrast using the phase-contrast method two theories suggest different forms of phase-plate. If $\Delta\phi$ is the phase difference in the object and $\Delta\psi$ that of the phase-plate in the objective, and if D is the transmission of the annulus one theory gives $\Delta\psi = f(\Delta\phi)$ and $D = F(\Delta\phi)$, the other gives $\Delta\psi$ const $= \pi/2$ and $D = G(\Delta\phi)$. Previous experimental work has failed to discriminate the correctness of one or other theory. An experimental procedure for investigating this has therefore been devised. A.

535.822.5

2653. A light filter combination for the observation of fluorescence in the whole visible spectral region. H. KÖLBEL. Note in *Naturwissenschaften,* **41,** *No.* 23, 550 (1954) In German.

In the use of a fluorescence microscope with a very-high-pressure mercury lamp the exciting ultraviolet is transmitted by the Schott glass UG 11, and the visible fluorescence from 4000 Å upwards by Schott VG 10. S. T. HENDERSON

HEAT 536

536.2 : 518.5

2654. Analog methods for study of transient heat flow in solids with temperature-dependent thermal properties. N. E. FRIEDMANN. Letter in *J. appl. Phys.,* **26,** *No.* 1, 129–30 (*Jan.,* 1955).

The spatial derivative of the temperature in the

equation of unidimensional heat flow in an isotropic stationary medium without internal heat sources and surface losses can be represented by a non-linear difference equation [Howe and Haneman, Abstr. 977 (1954)]. Two circuit arrangements, suitable for the electronic and circuit types of analogue computers respectively and using a non-linear resistance and capacitance respectively to simulate the non-linearity of the difference equation, are outlined. S. WEINTROUB

536.21

2655. The determination, by means of a new procedure, of the temperature distribution in a finite, long cylindrical body. L. v. SZALAY. *Frequenz*, **8**, *No.* 10, 302–4 (*Oct.*, 1954) In German.

It is shown that problems similar to that treated previously classically by the author can be solved more simply and elegantly by the use of the Picone procedure. S. WEINTROUB

536.21

2656. The solution of a particular heat conduction problem and its application to analogous physical problems. E. TRÄNKLE. *Frequenz*, **8**, *No.* 11, 334–8 (*Nov.*, 1954) In German.

The one-dimensional heat flow along an infinitely long cylinder, of finite cross-section, initially at temperature θ_0, placed at $t = 0$ with its end $x = 0$ in contact with a plate maintained at θ_1, is considered and an approximate solution, suitable for numerical calculation, is derived for $\theta(x, t)$. The solution becomes more exact as t increases, and for a given x, $\theta(x, t)$ is proportional to $1/\sqrt{t}$. Both the exact and approximate solutions are applicable to other physical problems, the illustrations discussed being diffusion and the charging of a condenser through an infinite line of distributed resistances and capacitances. S. WEINTROUB

536.21 : 537.311.3 : 536.48

2657. Thermal and electrical conductivities of solids at low temperatures. G. K. WHITE AND S. B. WOODS. *Canad. J. Phys.*, **33**, *No.* 2, 58–73 (*Feb.*, 1955).

An apparatus for measuring the thermal and electrical conductivities of solids at temperatures between 2° and 300°K is described. Results are presented of measurements of some dilute copper alloys, beryllium, bismuth and germanium. Where possible the lattice thermal conductivity has been deduced, directly or indirectly from the measurements, and its magnitude and variation with temperature are discussed with relation to theory. A.

536.212.2

2658. Thermal conductivity of metals and alloys at low temperatures. A review of the literature. R. L. POWELL AND W. A. BLANPIED. *Circ. Nat. Bur. Stand.*, *No.* 556, 68 *pp.* (1954).

An extensive compilation is given of the measured values of thermal conductivity for metals and alloys from room temperature down to approximately 0°K. The more extensive and important data are plotted in 48 graphs. The tables and graphs for the metallic elements and alloys are essentially complete for literature reference from 1900 to early 1954. For comparison, several graphs and tables are given for some representative dielectrics. A.

536.22 : 536.63 : 534.22 : 532.14

On the relation between the dispersion of the velocity of sound, the specific heat, the density and the thermal conductivity of glycerine. *See Abstr.* 2457

536.23

2659. Thermal conductivity of argon-neon mixture. B. N. SRIVASTAVA AND M. P. MADAN. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 587–97 (*Sept.–Oct.*, 1954).

A gas analysis apparatus based on the thermal conductivity of gas mixtures has been constructed using a hot-wire cell. A rigorous mathematical theory has been applied to calculate the various corrections and yield the value of the thermal conductivity in terms of conveniently observed quantities. The measurements have been made for argon-neon mixtures of various concentrations and the experimentally determined thermal conductivities for each concentration tabulated. The results are compared with the theory of the thermal conductivity of binary mixtures using the Lennard–Jones 12 : 6 model and the inverse power model, utilizing the known force constants. The results show a satisfactory agreement with the 12 : 6 model but not with the inverse power model. A.

536.24

2660. Components for sodium or NaK systems. W. B. COTTRELL AND L. A. MANN. *Nucleonics*, **12**, *No.* 12, 22–5 (*Dec.*, 1954).

Physical properties of sodium and NaK make these liquid metals particularly suitable as high-temperature heat-transfer fluids. Experiences in the use of various materials and components with liquid Na or NaK circuits are described. Some of the components, heat exchangers, e.m. and centrifugal pumps and Na system heaters, have been operated for more than 1000 hours at temperatures of 1500°F or more. L. R. SHEPHERD

536.241 : 539.621

2661. The division of heat between sliding bodies when their relative movement is not periodic. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 25, 1773–5 (*Dec.* 20, 1954) In French.

Previous investigations [Abstr. 6457 (1952)] of the heat developed between sliding surfaces were made neglecting the thermal capacity of the skid (of a flying machine) and the conductivity of the other surface. The work is now extended, taking into account quantities previously ignored, and a solution found for the temperature of the interface and the heat flow into the two bodies. F. E. HOARE

536.242

2662. The problem of the heat transfer of a liquid moving along a straight wall. A. I. PEKHOVICH. *Zh. tekh. Fiz.*, **24**, *No.* 6, 1020–1 (1954) In Russian.

536.244 : 533.011.6

Heating of bodies of various shapes by gases in direct and counter current. *See Abstr.* 2478

536.25

2663. Heat transfer by free convection across a closed cavity between vertical boundaries at different temperatures. G. K. BATCHELOR. *Quart. appl. Math.*, **12**, *No.* 3, 209–33 (*Oct.*, 1954).

The two-dimensional convective motion generated by buoyancy forces on the fluid in a long rectangle,

of which the two long sides are vertical boundaries held at different temperatures, is considered with a view to the determination of the rate of transfer of heat between the two vertical boundaries. The governing equations are set up; they reveal that the flow is determined uniquely by the Prandtl number σ, the Rayleigh number $A = g(T_1 - T_0)d^3/(T_0\kappa\nu)$, and the ratio of the sides of the rectangle l/d. In the case of cavities used for thermal insulation of buildings, which is kept specially in mind throughout the paper, A is usually about 1000 d^3 (where d is in centimetres), and l/d takes values between about 5 and 200. The essence of the problem is to determine which of several different flow regimes occurs at any given values of A and l/d. It appears that with the above practical values the flow is not decisively of one single kind, and the discussion of the heat transfer for each of several ranges of values of A and l/d is necessary. A comparison of the theoretical predictions about the heat transfer with the limited experimental data, mostly obtained by Mull and Reiher (1930), is made. Theory and experiment agree in suggesting that, under practical conditions, the effect of convection is negligible for $d \leqslant 1$ cm, and that the heat transfer per unit area of vertical boundary decreases as d increases, provided $d < 2{\cdot}5$ cm, and remains approximately constant (at a value proportional to $l^{-1/4}$) for further increase of d. A.

536.35

2664. Measurement of the reflecting power of paints. R. MÉRIGOUX. *J. Phys. Radium*, **15**, *No.* 12, 67 S–68 S (*Dec.*, 1954) In French.

A copper cylindrical block, with a small aperture to take a thermometer, is enclosed everywhere, except over one face, with blocks of cork. The exposed face can be treated with various paints, blackened or polished. After a steady thermal state has been reached, the treated face is exposed to heat radiation and the curve of temperature rise is determined. The tangent of the initial angle of slope of this curve is proportional to the absorption factor. One block, with the exposed face blackened, is taken as having an absorption of unity and this serves as a standard of comparison. J. W. T. WALSH

536.413 : 548.736.4

2665. Thermal expansion of potassium chlorate. M. A. LONAPPAN. *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 2, 75–80 (*Feb.*, 1955).

The principal coefficients of expansion and the orientation of the ellipsoid of expansion have been determined for potassium chlorate for the ranges 30 to 90, 90 to 150 and 150 to 200°C. An X-ray method was used and the expansion coefficient in the directions normal to the various planes in the zones [100], [010] and [001] were determined by recording the zero layer of the rotation photographs taken about the three axes in a Unicam high-temperature camera. The values of α_{22} and α_{33} are nearly equal (~ 30 to 40×10^{-6}) whereas the value of α_{11}($\sim 130 \times 10^{-6}$) is much higher than both. The direction of the greatest expansion coefficient is found to be almost perpendicular to the plane of the oxygen atoms according to Zachariasen's structure. The expansion coefficients along a, b and c axes and the rate of change of the monoclinic angle with temperature are also given, using which the lattice dimensions of the crystal at any temperature can be determined. A.

536.421.4

2666. Modern aspects of cryometry. Y. DOUCET. *Mem. Sci. phys., No.* 59, 129 *pp.* (1954) In French.

A detailed, comprehensive, mathematical survey. The subjects considered include general principles, ideal solutions, real dilute solutions, solutions of non-electrolytes and electrolytes, the saline state, eutectic mixtures and molten salts. E. H. DOCK

536.422.15

2667. The vapor pressure of zirconium fluoride. K. A. SENSE, M. J. SNYDER AND R. B. FILBERT, JR. *J. phys. Chem.*, **58**, *No.* 11, 995–6 (*Nov.*, 1954).

Using the transpiration method, the vapour pressures of ZrF_4 were measured over the temperature range of 616–881° and the pressure range of 0·3–470 mm. The extrapolated sublimation point is 903°. A.

536.422.5 : 535.41

2668. Optical interference on thin ice films condensed at −190°C. E. REGENER. *Mitt. Max Planck-Inst. Phys. Stratosphäre, No.* 3, 8 *pp.* (1954). In German.

An apparatus is described in which thin layers of ice are formed slowly by condensation in a vacuum from a region cooled by solid CO_2 on to a region cooled by liquid air. The initial stages of the film are sufficiently uniform for interference fringes to be formed between the two ice surfaces. Wedge fringes up to 60 in number can be followed as the film grows, after which the top surface becomes too irregular and nodules form. The rate of deposition over half an hour can be followed and thus the vapour pressure could be evaluated. This is not, however, done here. S. TOLANSKY

536.423.1 : 536.51

2669. Thermodynamic temperature scale below 90°K, the normal boiling point of normal hydrogen. G. W. MOESSEN, J. G. ASTON AND R. G. ASCAH. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2096–7 (*Dec.*, 1954).

Tabulates the difference between the authors' temperature scale based on gas thermometry [Abstr. 6002 (1953)] and that of the National Bureau of Standards; when the latter is corrected in accordance with the new boiling point of O, the agreement is excellent. The authors' value for the normal boiling point of H is 20·365°K, the average of all other values obtained since 1930 being 20·379°K. F. LACHMAN

536.423.15 : 539.155.2

2670. Vapor pressure studies involving solutions in light and heavy waters. I. The apparatus and the determination of vapor pressures at 30° of solutions of sodium and potassium chlorides in ordinary water. H. A. SMITH, R. L. COMBS AND J. M. GOOGIN. *J. phys. Chem.*, **58**, *No.* 11, 997–9 (*Nov.*, 1954).

An apparatus for the determination of the vapour pressures of solutions relative to the vapour pressure of water is described. The vapour pressure lowerings of water caused by the presence of various concentrations of sodium chloride and potassium chloride have been determined. A.

536.423.15 : 539.155.2

2671. Vapor pressure studies involving solutions in light and heavy waters. II. The vapor pressure of heavy water and the separation factor of the mixed waters. R. L. Combs, J. M. Googin and H. A. Smith. *J. phys. Chem.*, **58**, *No.* 11, 1000–1 (*Nov.*, 1954).

The vapour pressure of deuterium oxide has been precisely determined over the temperature 10 to 55°. The results are slightly different from those previously reported. The separation factor $\alpha = (H/D)_{gas}/(H/D)_{liquid}$ has also been determined for a mixture of the two waters. A.

536.44

2672. Relation between isotherms and coexistence curve in the critical region. O. K. Rice. *J. chem. Phys.*, **23**, *No.* 1, 169–74 (*Jan.*, 1955).

A general relation has been given relating the slope of the isotherms along the liquid-vapour coexistence curve to the shape of the latter, and has been applied to the case where the coexistence curve is rounded on the top and to the case where it has a flat horizontal portion. If the coexistence curve has the form $T-T_c = -a|\rho_c-\rho|^n$ (where T = temperature, ρ = density, subscript c indicates a value at the critical point, and a and n are constants) it can be shown that the critical isotherm is given by $P-P_c = a(\partial^2P/\partial T\partial\rho)_c(\rho-\rho_c)|\rho-\rho_c|^n$, provided $(\partial^2P/\partial T\partial\rho)_c$ is finite. This equation should hold over the region where $\partial^2P/\partial T\partial\rho$ is approximately constant. If there is a flat, horizontal portion at the top of the isotherm a similar equation will be approximately true under the same conditions beyond the flat portion. The actual shape of experimental isotherms in the critical region is considered. $\partial^2P/\partial T\partial\rho$ is approximately constant only over a limited range of densities, and beyond this range the slopes of the isotherms become greater than indicated by the equation; however, general orders of magnitude are as expected. It is not possible to decide definitely from the data considered whether the critical isotherm has a horizontal region over a finite range of densities. Finally, a discussion is given of the discontinuities of thermodynamic quantities, particularly C_v, as one passes from the one-phase to the two-phase region. It is shown that C_v must be much larger in the two-phase than in the one-phase region. A.

536.44 : 541.123

2673. The shape of the coexistence curve near the critical temperature. O. K. Rice. *J. chem. Phys.*, **23**, *No.* 1, 164–9 (*Jan.*, 1955).

It is shown that diffusion in the gravitational field in binary liquid systems is so slow that the effect of gravity may be completely neglected in studies of the coexistence curve. The data arising from the direct measurement of the coexistence curve of the cyclohexane-aniline system have been correlated with those from measurements of the densities of coexisting phases. A graph has been constructed which confirms the earlier conclusion that the coexistence curve is flatter at the top than can be accounted for by a cubic relation between temperature and density. Finally, a discussion is given of the liquid-vapour equilibrium in a one-component system. It is pointed out that the range of densities over which the meniscus has been reported to disappear within the tube in earlier work is so small that measurements of the coexistence curve need to be made with a temperature control of the order of 0·0001 deg. Only the recent work of Lorentzen on carbon dioxide meets this requirement. His data appear to be favourable to the idea that there is a short flat portion on the top of the coexistence curve, but are still not quite adequate to settle the question. A.

536.46

2674. Flame quenching by a variable-width rectangular-channel burner as a function of pressure for various propane–oxygen–nitrogen mixtures. A. L. Berlad. *J. phys. Chem.*, **58**, *No.* 11, 1023–6 (*Nov.*, 1954).

The relation between pressure p and quenching distance d, is given by $d\alpha p^{-r}$, with $r \simeq 1$ for equivalence ratios approximately equal to one (for pressures of 0·1 to 1·0 atm and for volumetric oxygen fractions of the oxidant mixture of 0·17, 0·21, 0·30, 0·50 and 0·70). For lean and stoichiometric mixtures, it is shown that an equation based on a diffusion mechanism may be used successfully to correlate the observed quenching data. A.

536.46

2675. The determination of burning velocities of slow flames. G. N. Badami and A. Egerton. *Proc. Roy. Soc. A*, **228**, 297–322 (*March* 8, 1955).

Measurements of the burning velocities of methane, ethane, propane, butane, ethylene, carbon monoxide and cyanogen mixtures with air, in the range about 4 to 8 cm, are made by the flat-flame burner method with an accuracy of 2 to 3%. The results can be represented by a straight-line relationship between composition and burning velocity except for carbon monoxide which is sensitive to the percentage of water vapour present. Extrapolated values agree well with recent measurements of faster flames. Measurements are also made on binary mixtures with air of the gases, including hydrogen. The mixture law holds except with mixtures containing carbon monoxide. Limits of inflammability are also determined and the burning velocities at the limits average 3·6 cm/sec. The mixtures obey the Le Chatelier rule accurately, except for carbon monoxide mixtures. The burning velocities of the hydrocarbons can be represented approximately by a straight-line relationship with the heat generated and with the maximum flame temperature, but correlation is best when thermal conductivity is introduced. At a given velocity the excess energy maintained by the flame appears to be constant for all the hydrocarbons investigated, except methane, which behaves slightly differently. The burning velocities of the hydrocarbons are controlled by a reaction which provides reasonable values of the activation energies and probably precedes the sudden development of chain branching. A.

536.461

2676. Effect of turbulence on incipient flame propagation. H. L. Olsen and E. L. Gayhart. Letter in *J. chem. Phys.*, **23**, *No.* 2, 402–3 (*Feb.*, 1955).

Schlieren photographs of spark-ignited flame kernels are shown for laminar flow and for turbulent flow induced by a grid. In the region of isotropic turbulence well above a 10-mesh grid, there is no

increase in flame propagation rate; this contrasts with generally accepted ideas. With ¼ in. and ½ in. grids there is some increase in rate close to the grid. Greater velocity gradients quench rather than enhance propagation. A. G. GAYDON

536.462 : 535.33

2677. Experimental determination of rotational temperatures and concentrations of OH in flames from emission spectra. S. S. PENNER AND E. K. BJÖRNERUD. *J. chem. Phys.*, **23**, *No.* 1, 143–52 (*Jan.*, 1955).

In order to illustrate the use of two-path experiments for correcting for self-absorption, experimental studies to determine the rotational "temperatures" and concentrations of OH in flames burning at atmospheric pressure have been carried out. For mixtures of H_2, C_2H_2, and O_2, as well as for C_2H_2–O_2 flames diluted with A, "anomalous" rotational "temperatures" were observed under conditions in which strong self-absorption was clearly indicated by the intensity ratios for the double-path to the single-path experiments. Unequivocal quantitative estimates of rotational temperatures and of OH concentrations cannot be carried out, even on the assumption that the emitting system is isothermal and in equilibrium. However, by using the results of theoretical studies on two-path experiments carried out by one of the authors, it is possible to obtain reasonable upper limits for the temperatures and lower limits for the OH-concentrations, based on an assumed Doppler contour for the line-shape and utilizing Oldenberg's estimates for the f values of representative spectral lines. Experimental studies lead to reasonable rotational temperatures at the tip of luminous cones for mixtures of H_2, C_2H_2, and O_2 and for C_2H_2–O_2 flames diluted with up to 60% argon. These observations do not disprove the reality of rotational temperature anomalies in the inner cones of flames. Significant improvement of experimental procedure, and quantitative interpretation of results, require additional basic studies with emphasis on the measurement of spectral line-shape and absolute intensities. A.

536.48 : 539.58

2678. Compressibilities of some solidified gases at low temperature. J. W. STEWART. *Phys. Rev.*, **97**, *No.* 3, 578–82 (*Feb.* 1, 1955).

The compressibilities have been measured by applying a one-sided compression directly to a cylindrical sample, and observing the resulting volume change. Pressure was conveyed to the samples at low temperature by means of long stainless steel compression and tension members. Preliminary extrusion experiments with these solidified gases assured that the pressure applied to the samples was always at least approximately hydrostatic. Compressibility data have been obtained at pressures up to 10 000 kg/cm² for solid hydrogen and deuterium at 4°K, and to 4000 kg/cm² for solid neon at 4°, solid argon at 65° and 77°, and solid krypton at 77°. A single less accurate determination has also been made for solid nitrogen up to 3000 kg/cm². A.

536.48

2679. Specific heats of pure ^{4}He and of a mixture of ^{4}He with 2·50% of ^{3}He between 1°K and 2·3°K. Z. DOKOUPIL, G. VAN SOEST, D. H. N. WANSINK AND D. G. KAPADNIS. *Physica*, **20**, *No.* 12, 1181–8 (*Dec.*, 1954).

A method for the determination of the heat capacity of small quantities of isotopic mixtures of liquid helium has been developed and used also for the measurement of the specific heat of He^4. The scattering of the experimental points within 4% along the smoothed curve given by Kramers, Wasscher and Gorter confirms their results. The same experimental setup has been used for the determination of the specific heat of a mixture of He^4 with 2·50% of He^3 between 1·05 and 2·3°K. With respect to pure He^4 an appreciable increase of the heat capacity of the mixture (about 40% at 1·1°K, the relative increase diminishing with the rise in temperature) and a shift of the λ-temperature of 0·037°K has been found as a result of three series of measurements. A.

536.48

2680. Surface tension of He^3. D. R. LOVEJOY. *Canad. J. Phys.*, **33**, *No.* 2, 49–53 (*Feb.*, 1955).

The surface tension of He^3 has been measured by a capillary rise method between 1·08° and 2·32°K. A decrease of more than 50% was observed in this range and this supports the ideas on which Atkins' theory of the surface tension of liquid helium is based. On the basis of this theory the surface tension has been extrapolated to 0°K where it has the value 0·154 ± 0·005 erg cm^{-2}. Above 2·3°K it was extrapolated linearly to zero at the critical temperature. The Eötvös constant was calculated to be about 0·8. A.

536.48 : 532.73

2681. Thermodynamic properties of He^3 and He^4 solutions. V. S. NANDA. *Phys. Rev.*, **97**, *No.* 3, 571–7 (*Feb.* 1, 1955).

The thermodynamics of mixing of He^3 and He^4 solutions has been investigated on the basis of the existing theories. De Boer and Gorter's theory is modified to take account of the non-ideal character of the solution above the λ-temperature. The theoretical vapour pressure results are compared with Sommers' measurements at the dew point. It is found that certain features can be explained only on the de Boer–Gorter–Taconis approach. However, the incompatibility of any theory based on Taconis' hypothesis with Sommers' extensive vapour pressure measurements at fixed liquid concentrations prevents drawing any definite conclusions. Valuable information about the proper choice of the model for He^3 and He^4 solutions might, however, be obtained by an experimental study of the variation of heat of mixing and specific heat of mixing with temperature and concentration. A.

536.48

2682. Can helium-3 be expected to exhibit superfluidity at sufficiently low temperatures? O. K. RICE. Letter in *Phys. Rev.*, **97**, *No.* 2, 558–9 (*Jan.* 15, 1955).

Making use of a hypothesis according to which pairs of He^3 atoms are in some way linked together, the author advances the suggestion of liquid He^3 becoming superfluid at a temperature of 0·05°K. R. EISENSCHITZ

536.48

2683. Reversible generation of temperature waves ("second sound") in liquid helium II. N. KURTI AND J. MCINTOSH. Letter in *Phil. Mag.*, **46**, 104–5 (*Jan.*, 1955).

These were generated in a resonant cavity by a pill of compressed ferric ammonium alum in an alternating magnetic field at frequencies between 150 and 1200 c/s. The temperature excursions as measured by a carbon resistance thermometer were of the order of 10^{-4} deg., while the temperature amplitudes of the spin system of the salt were 10^{-2} deg. The deduced second sound velocities between 1·3° and the λ-point agree with those obtained by previous authors. The efficacy of this method increases with decreasing temperature and the method seems suitable for experiments below 1°K. H. LONDON

536.483

2684. The hydrogen and helium liquefier at the A. Cotton Laboratory at Bellevue. General remarks on helium liquefiers. R. SPOENDLIN. *J. Rech. Cent. Nat. Rech. Sci.*, **6**, 1–14 (*Sept.*, 1954) In French.

Description of a liquefier, with a production rate of 7 litres/hour of liquid hydrogen and 5 litres/hour of liquid helium. Discusses the best positions for the exchangers, and the power losses due to the irreversibility of the various circuits (heat pumps) at very low temperatures. The advantages of liquefaction in cascade, even for helium, is shown with the aid of an example. H. C. COLE

536.62

2685. Adiabatic calorimeter for use with condensable gases and gas-solid systems between 10 and 150°K. E. L. PACE, L. PIERCE AND K. S. DENNIS. *Rev. sci. Instrum.*, **26**, *No.* 1, 20–2 (*Jan.*, 1955).

The construction is described in detail concerning the features in which it differs from calorimeters previously described in the literature. These features have resulted in an improved performance and precision. At 30°K, its precision was better than 0·1%, while at temperatures above 50°K, a precision of 0·03% or better is indicated. At the lowest temperatures, an uncertainty of 1% exists, largely the result of the decreasing sensitivity of the platinum resistance thermometer. A.

536.631 : 536.48 : 539.132

2686. Spin coupling and specific heat anomalies at liquid helium and hydrogen temperatures of the complex acetate $[Cr_3(CH_3COO)_6(OH)_2]Cl.8H_2O$. J. WUCHER AND J. D. WASSCHER. *Physica*, **20**, *No.* 10, 721–6 (*Oct.*, 1954) In French.

The low-temperature experimental specific heat data are interpreted in terms of the ground state splitting for the molecule of three chromic ions, using an anisotropic spin Hamiltonian as in earlier magnetic work [Abstr. 10330 (1954)]. E. P. WOHLFARTH

536.633.3 : 530.162

2687. The effect of vorticity on the specific heat ratio of a non-relativisitic Fermi–Dirac gas. M. S. VARDYA. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 570–5 (*Sept.–Oct.*, 1954).

The ratio is found to increase with vorticity. A.

536.66 : 539.132

2688. Heat of formation of NH(*g*) and the bond dissociation energy *D*(NH–H). A. P. ALTSHULLER. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1947–8 (*Nov.*, 1954).

On the basis of data now available the set of bond dissociation energies $D(NH_2 - H)$, $D(NH - H)$, $D(N - H)$ and heats of formation of $NH_3(g)$, $NH_2(g)$ and $NH(g)$ is completed by the evaluation of $\Delta H_f(NH, g)$ and $D(NH - H)$. These last are found to be 77 and 88 kcal/mole respectively. The values found are discussed. 20 references are given.

A. J. TAYLOR

THERMODYNAMICS 536.7/.8

536.7

2689. On the minima of entropy production and the dissipation of energy. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 5, 779–83 (1954) In French.

In a material system undergoing an irreversible process the nonequilibrium stationary states are characterized by a minimum in the entropy production, according to Prigogine, provided certain restrictive conditions are fulfilled. These are that the kinetic laws are linear, the Onsager reciprocal relations satisfied and the phenomenological coefficients are constant. This last condition is discussed in detail and examples given by Prigogine critically examined. F. E. HOARE

536.7

2690. In search of a general definition of energy and of parameters describing extension and intensity. P. RENAUD, M. JOLY AND D. G. DERVICHIAN. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1603–5 (*Dec.* 8, 1954) In French.

An abstract scheme describing the relation between energy on the one hand and intensive and extensive parameters on the other. It is claimed that it will be possible to fit forms of energy at present unknown into the framework provided. R. O. DAVIES

536.7 : 536.48

2691. Thermodynamic properties of quantum solids at the absolute zero. R. BINGEN. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 8, 815–33 (1954) In French.

A chain of anharmonic oscillators is studied, and the effect of the volume on the elastic constants, and of the anharmonicity on the zero-point energy is discussed. P. T. LANDSBERG

536.7 : 536.48

2692. Non-equilibrium thermodynamics with finite reaction velocity and liquid helium II. B. N. SRIVASTAVA, R. P. RASTOGI AND A. S. VERMA. *Physica*, **20**, *No.* 12, 1271–7 (*Dec.*, 1954).

The thermodynamics of irreversible processes as developed by Onsager, De Groot and others have been recently applied to the case of thermal effusion of a fluid consisting of two isomers with a finite velocity of transformation. More general formulae than those of De Groot, Jansen and Mazur have been obtained, by considering the velocity of transformation to be

different in the two chambers on account of the difference in temperature. Application of these results to liquid helium II is discussed, and their importance in the study of chemical equilibria pointed out. A.

536.7 : 537.31

2693. On the thermomechanics of electrical conduction. J. E. VERSCHAFFELT. *J. Phys. Radium*, **15**, *No.* 11, 742–9 (*Nov.*, 1954) In French.

After further developments of the author's theory of transport phenomena it is applied to electrical conduction by electrons and ions. An explanation of the action of a concentration element and the fall of potential at the electrodes is given. F. E. HOARE

536.75 : 541.124

2694. Entropy production and the stationary state of chemical reactions. H. C. MEL. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 8, 834–45 (1954).

On the basis of a theorem recently proved by Glansdorff and Prigogine [Abstr. 1790 (1955)] that the change of entropy production caused by change of free energy ($d_A P$) has a well-defined sign, independent of the kinetics, it is proved for a large class of "normal" nonlinear kinetic laws (normal in the sense that an increase of concentration of one component increases the rate of the reaction in which it participates) the change of entropy caused by change of velocities ($d_V P$) is negative even if the system is quite far from equilibrium, provided it is far from the stationary state, and this means that total entropy production ($d_A P + d_V P$) must decrease. The entropy production in the stationary state must be much smaller than in the steady state. R. C. MURRAY

536.76

2695. Note on Ehrenfest's equations. C. G. KUPER. Note in *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 1, 243–4 (*Jan.*, 1955).

Ehrenfest's classification of phase transitions is incomplete. It is shown, however, that with a slightly modified interpretation Ehrenfest's equations hold for all transitions other than those of the first order. The application to the λ-transition in helium is discussed briefly. F. E. HOARE

ELECTRICITY 537

537.12 : 530.145.5

2696. Method for determining the ratio of Planck's constant to the charge of the electron employing a.c. amplification. G. F. LANDEGREN. *Amer. J. Phys.*, **23**, *No.* 2, 87–8 (*Feb.*, 1955).

Filtered pulsating light from a mercury vapour lamp operated on a.c. is directed upon a commercial high-vacuum phototube, and the photocurrent, which is thereby pulsating d.c. is passed by an a.c. amplifier whose output is fed to a d.c. milliammeter through a copper oxide rectifier. Using different light filters a retarding potential of increasing magnitude is applied to the phototube until the milliammeter readings reach respective minimum values which are plotted as ordinate against optical frequency as abscissa. The slope of the resulting line is taken as h/e. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.212 : 537.52

2697. The determination of electric discharge fields with a special klydonograph. H. NORINDER AND O. SALKA. *Ark. Fys.*, **8**, *Paper* 35, 355–6 (1954).

A special klydonograph may be used for the measurement of field intensities, even single impulses. It allows the field intensity to be measured directly, without intermediate operations. It is not possible to calibrate the klydonograph theoretically; it must be done experimentally. It is preferable to employ negative figures for measuring purposes, since they increase continuously. The positive figures do not increase in size continuously with the field intensity: there is a discontinuity, at about 10 kV/cm in the present case. Figures of both polarities reach a stage of instability at about 20 kV/cm, after which the figures cover the whole film disk. The measuring range of the standard klydonograph used (with a point electrode 17 mm long) was from 2·5 to 20 kV/cm. However, this range may be extended upwards or downwards by a suitable choice of point length. The error of the measurements is about 20%. The klydonograph may also be used to determine the direction of the field. Furthermore, it provides information about the steepness of the impulse front. A.

537.212 : 621.319.4 : 621.3.013

2698. The field due to an infinite dielectric cylinder between two parallel conducting planes. C. MACK. *Brit. J. appl. Phys.*, **6**, *No.* 2, 59–62 (*Feb.*, 1955).

It is shown that, whatever the distance of the cylinder from the planes, this field can be calculated by first solving an infinite set of linear equations with comparatively simple coefficients. By neglecting all except the first few unknowns, a good approximation to the correct solution is obtained. The simplest approximation is sufficient for most practical purposes, and it is shown that the increase in capacitance between the planes due to the presence of the cylinder is nearly proportional to the cylinder (radius)$^2 \times$ a simple function of its permittivity, provided that this radius is small compared with the distance between the planes. A.

537.223

2699. Physical problems of electrostatic generators. N. FÉLICI. *J. Phys. Radium*, **15**, *No.* 12, 75 S–76 S (*Dec.*, 1954) In French.

A brief discussion of the factors governing the selection of gaseous and solid insulating materials for the construction of electrostatic generators.

A. E. KAY

537.226 : 621.315.61

2700. Digest of the literature on dielectrics. Volume XVII—1953. Edited by A. E. MIDDLETON AND H. M. PHILOFSKY. *Washington: National Academy of Sciences—National Research Council Publication* 330 (*Oct.* 15, 1954) 177 *pp.*

This annual volume is prepared by the Committee on Digest of Literature of the Conference on Electrical Insulation. *Instrumentation and Measurements*, R. A. Soderman (1–9) 73 refs. *Molecular and ionic inter-*

actions in dielectrics, J. G. Powles (10–18) 84 refs. *The breakdown of dielectrics*, R. W. Crowe and A. H. Sharbaugh (19–38) 96 refs. *Ferroelectric and piezoelectric materials*, W. R. Cook, Jr and H. Jaffe (39–51) 131 refs. *Ferromagnetic materials*, D. J. Epstein (52–65) 90 refs. *Synthetic plastic insulation*, C. H. Adams and J. R. Taylor (66–71) 64 refs. *Rubber insulation*, S. Palinchak (72–6) 38 refs. *Insulating films*, H. A. Birdsall (77–83) 35 refs. *Insulating liquids*, J. E. Gibbons (84–95) 59 refs. *Ceramic insulation*, E. A. Giess and J. H. Strimple (96–103) 74 refs. *Theory and general information on semiconductors*, A. C. Beer (104–23) 139 refs. *Elemental semiconductors*, S. J. Angello (124–38) 73 refs. *Semiconducting compounds*, M. Tanenbaum (139–60) 196 refs. *Photosensitive and luminescent materials*, A. C. deWilde (161–77) 145 refs.

537.226.1.08 : 621.317.335.3

2701. Phase and amplitude balance methods for permittivity measurements between 4 and 50 cm. T. J. Buchanan and E. H. Grant. *Brit. J. appl. Phys.*, **6**, *No.* 2, 64–6 (*Feb.*, 1955).

Coaxial-line equipment has been constructed to measure a wide range of permittivities of liquids in the wavelength range 4 to 50 cm. Several alternative ways of using the apparatus are given, and two types of liquid cell are described. The apparatus has been used mainly for medium-loss but also for high-loss liquids. For very low-loss liquids the accuracy is low and cavity methods are essential. A.

537.226.2

2702. Measurements of the principal dielectric constants of magnetically oriented liquid crystal phases. W. Maier, G. Barth and H. E. Wiehl. *Z. Elektrochem.*, **58**, *No.* 9, 674–80 (1954) In German.

The dielectric constants ε_1 and ε_2 of molten 4, 4′ di-*p*-methoxy-azoxybenzene and 4, 4′ di-*p*-*n*-pentoxyazoxy-benzene in directions parallel and perpendicular to a magnetic field were measured. $\varepsilon_2 - \varepsilon_1$ is independent of the field strength above 1000 gauss, and decreases linearly with rising temperature. There is a sharp transition temperature at which $\varepsilon_2 - \varepsilon_1$ vanishes. The results are briefly discussed in terms of the molecular structure. P. CUCKA

537.226.2

2703. Some experiments on WO_3 single crystals. K. Hirakawa and I. Ueda. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, *No.* 4, 112–14 (*March*, 1954).

Single crystals show remarkable anisotropy ($\varepsilon_A = 9\times10^4$, $\varepsilon_B = 4\times10^4$, $\varepsilon_C = 6\times10^3$) but all values fall to ~300 at $< -50°$C, when the crystals break into multidomain systems. Because of its semiconducting character it is uncertain whether WO_3 is ferroelectric. J. H. MASON

537.226.2

2704. Dielectric constants of liquid and solid hydrogen sulfide. S. Havriliak, R. W. Swenson and R. H. Cole. *J. chem. Phys.*, **23**, *No.* 1, 134–6 (*Jan.*, 1955).

The equilibrium dielectric constants of the disordered highest-temperature solid phase show a regular increase with decreasing temperature which is in moderate agreement with Onsager's equation. Larger values than would be expected on this basis are found in the intermediate solid phase, while the values in the ordered phase below 103°K are a little larger than the square of the estimated refractive index. No evidence of relaxation effects or of electrode polarization was found in the frequency range from 15 c/s to 500 kc/s studied. A.

537.226.2 : 535.324.2

2705. On the specific inductive capacity and the index of refraction of solutions of polar bodies (nitrobenzene, acetone, dichlorethane) in a non-polar solvent (benzene). R. Arnoult and J. Fontaine. Letter in *J. Phys. Radium*, **15**, *No.* 10, 696 (*Oct.*, 1954) In French.

Equations of the form

$$\varepsilon_{12} = \varepsilon_1 f_1 + \varepsilon_2 f_2 - \kappa f_1 f_2,$$
$$n_{12} = n_1 f_1 + n_2 f_2 + \kappa' f_1 f_2,$$

where f are mole fractions, are shown experimentally to relate the dielectric constants and the refractive indices of mixtures to those of the pure components 1 and 2. From ε_1, ε_2 and κ the polarization of the solute at infinite dilution may be obtained without the need for extrapolation. D. H. WHIFFEN

537.226.2 : 541.183

2706. Dielectric properties at centimetre waves of water adsorbed on silica gel. J. Le Bot and S. Le Montagner. *J. Phys. Radium*, **16**, *No.* 1, 79–80 (*Jan.*, 1955) In French.

537.226.2 : 621.315.612.4

2707. Ferroelectric properties of solid solutions of barium stannate in barium titanate. G. A. Smolenskiĭ and V. A. Isupov. *Zh. tekh. Fiz.*, **24**, *No.* 8, 1375–86 (1954) In Russian.

The volumetric electrostriction of solid solutions with small barium stannate content is greater than 1 in the Curie range. Solid solutions with small electrostriction (10–12% $BaSnO_3$) have high maximum permittivity in weak fields, their relationship between permittivity and field strength is sharply defined. The permittivity of solid solutions with high barium stannate content changes considerably with small temperature changes. The Curie temperature of solid solutions decreases when barium stannate content increases. At the same time low-temperature phase transformations move towards higher temperatures. A change of structure from cubic to rhombohedral occurs on cooling solid solutions containing > 12% of barium stannate. Piezo-oscillations occur in solid solutions with sufficiently high barium stannate content at temperatures higher by 20–30°c than corresponding values for maximum dielectric permittivity. Solid solutions have no single Curie temperature but a range of Curie temperatures, which can be explained by considerable internal stresses. The resonance frequencies and consequently the modulus of rigidity of the solid solutions investigated increase with barium stannate content. J. LUKASZEWICZ

537.226.2

2708. Dielectric properties of lead–strontium titanate. S. Nomura and S. Sawada. *J. Phys. Soc. Japan*, **10**, *No.* 2, 108–11 (*Feb.*, 1955).

The dielectric and thermal properties and lattice dimensions of lead–strontium titanate were investigated, the solid solution being realized in the whole

range of molar percentage. It was found that lead–strontium titanate is ferroelectric, as are lead–barium titanate and barium–strontium titanate. As the content of Sr^{2+} increases, the lattice volume and tetragonality decrease. The Curie temperature decreases linearly with the increase of the content of Sr^{2+} and any other transition point was not observed. Curie–Weiss formula holds above Curie temperature, the value of Curie constant being $(3 \sim 9) \times 10^4$°C. A.

537.226.2

2709. Dielectric properties of titanates containing Sn^{4+} ions. I. S. NOMURA. *J. Phys. Soc. Japan*, **10**, *No.* 2, 112–19 (*Feb.*, 1955).

Dielectric and thermal properties and lattice constants of the solid solutions of $Pb(Ti.Sn)O_3$ and $Ba(Ti.Sn)O_3$ were investigated, for the purpose of making clear the role of Y ion in the compounds of the perovskite type, XYO_3. In $Pb(Ti.Sn)O_3$, according to X-ray analysis, two phases seem to co-exist in the samples containing Sn^{4+} ions more than 75%, although the whole range solid solution might be expected from the standpoint of the "tolerance factor." The Curie point moves to the low-temperature side with the increase of the content of $PbSnO_3$ and reaches 200°c in Pb(20% Ti.80% Sn)O_3. In $Ba(Ti.Sn)O_3$, a rather steep decrease of the Curie temperature with the content of Sn^{4+} ions occurs and the whole range solid solution seems to be realized, although the X-ray analysis was not thoroughly made in this case. The dielectric constant $D \sim E$ hysteresis loop, thermal expansion and specific heat were observed. An anomalous hysteresis phenomenon was observed in Pb(25% Ti.75% Sn)O_3, which suggests that Ti^{4+} ion and Sn^{4+} ion respond differently to the external field in the ferroelectric state. A.

537.226.2 : 621.315.612.4

2710. Aging of the properties of barium titanate and related ferroelectric ceramics. W. P. MASON. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 73–85 (*Jan.*, 1955).

Barium titanate ceramics show an ageing effect during which the dielectric constant and electromechanical coupling factor decrease while the elastic constants and Q increase. At room temperature, this process takes over a year to stabilize. By heating the ceramic up to 70°c the process is considerably shortened. A comparison of the rates of ageing at 70°c and 25°c shows that an activation energy of about 19 kilocalories per mole is involved in the ageing process. The experiments and calculations made show that the cause of the ageing is a reduction in the effective polarization caused by a slow temperature-induced motion of the domain walls of the ceramic. This motion is biased by the residual strains stored up when the crystal becomes ferroelectric and also by strains induced by the poling process. It appears likely that the high activation energy measured arises from the simultaneous motion of a number of unit cells in a bordered wall. Due to this high activation energy ageing can be speeded up by a heat treatment process. A.

537.226.3 : 548.7

2711. On dipole resonance of associated defects in silver bromide. J. TELTOW AND G. WILKE. Note in *Naturwissenschaften*, **41**, *No.* 18, 423–4 (1954) In German.

Addition of $CdBr_2$ or $PbBr_2$ ($\sim 0{\cdot}05$ mol %) to AgBr causes its loss factor, tan δ, to reach a maximum proportional to the concentration of additive at a temperature of about −115°c. This can be explained by assuming almost complete association of Ag^+ holes and Cd^{++} ions, if proper corrections are applied to the field. Assumption of no association leads to too low an association energy and is inconsistent with the diffusion data and the peak height variation with additive concentration. P. CUCKA

537.226.32 : 621.319.2

2712. The origin of homocharge in naphthalene electrets. W. BALDUS. *Z. angew. Phys.*, **6**, *No.* 11, 481–9 (1954) In German.

An account of apparatus for preparing electrets under controlled conditions using metallic and non-metallic electrodes, with details of the variation with time of the heterocharge and homocharge and the magnitude of the homocharge at different depths below the surface. The space charge distribution in the interior of electrets is discussed theoretically.

J. H. MASON

537.226.33

2713. Electromechanical activity of $BaTiO_3$ ceramics due to opposite polarization. T. F. HUETER AND D. P. NEUHAUS. Note in *Naturwissenschaften*, **41**, *No.* 18, 424 (1954) In German.

Graphs show the variation in amplitude of the fundamental and 2nd harmonic frequencies when a reverse field of the order of the coercive field strength is applied. Two distinct types of polarization are indicated; the majority is readily depolarized at low field strengths, but complete disorder occurs only at much greater reverse fields. The effect is analogous to the constricted hysteresis loop which is observed when $BaTiO_3$ is subject to high a.c. stress.

J. H. MASON

537.228 : 621.315.612.4

2714. Piezoelectric materials made of pressed barium titanate. A. I. KOGAN AND M. M. KITAĬGORODSKIĬ. *Zh. tekh. Fiz.*, **24**, *No.* 8, 1371–4 (1954) In Russian.

Samples of barium metatitanate and solid solutions of barium metatitanate and lead, obtained by baking in temperatures up to 1250°c and compressing with an organic binder have piezoelectric properties after polarization. Samples obtained by compressing solid solutions of barium metatitanate and lead have greater piezo-modulus than samples of barium metatitanate, which may be explained by the lower baking temperature for the solid solution. The piezo-modulus d_{11} was found to range from $0{\cdot}6 \times 10^{-7}$ to 10^{-6} c.g.s.e. The permittivity of the same samples ranged from 40 to 95. J. LUKASZEWICZ

537.228.1

2715. Piezoelectricity of wood. E. FUKADA. *J. Phys. Soc. Japan.* **10**, *No.* 2, 149–54 (*Feb.*, 1955).

The direct and converse piezoelectric effects of wood have been studied. Assigning the z axis to the grain direction and the x and y axes to the radial and tangential direction of annual rings respectively, the

piezoelectric effects corresponding to d_{14} and d_{25} were observed. When the shearing force is applied to the fibres in their oriented plane, the polarization occurs on their side planes. The effect is symmetrical to the z axis, that is, the grain direction. Converse effects were observed by clamping together the wood specimen and a Rochelle salt crystal between metal frames, and measuring the output voltage of the Rochelle salt crystal when an alternating voltage at audio frequency is applied to the wood specimen. The value of the piezoelectric constants, $-d_{14} = d_{25}$, is in the order of 10^{-9} and about one-twentieth of d_{11} of quartz. If it is assumed that the natural cellulose possesses piezoelectricity in its crystalline state, that the micelles are oriented in only one direction, namely the z axis, in which positive and negative directions of the long axis of the micelles are equally distributed and that the micelles are arranged quite at random in the x y plane, the apparent piezoelectricity of wood is reasonably explained. A.

537.247.4 : 539.16.08

2716. Recording integrating photoelectric and radioactive scanner for paper electrophoresis and chromatography. E. L. Durrum and S. R. Gilford. *Rev. sci. Instrum.*, **26**, *No.* 1, 51–6 (*Jan.*, 1955).

A versatile automatic scanner for paper strips which records directly optical density or radioactivity is built around a servo type recorder (Brown). Interference filters provide a narrow band light source. For scanning in the visible or ultraviolet when monochromatic light is desired the monochromator of a Beckman model DU spectrophotometer replaces the filters. The instrument incorporates positive synchronization of strip and recording paper, sequential scanning of strips to provide an optical density curve followed by superposition of the integral of this curve. Areas are easily calculated without the need for planimetry. The slits of varying size are interchangeable and are designed for either optical or radioactive scanning. For medium levels of activity a Geiger-Muller tube is interchangeable with the photocell, while for low activities, optical scanning of autoradiographs may be performed. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3.08 : 621.317.715 : 621.375

2717. A tuned galvanometer amplifier. J. R. Beattie and G. K. T. Conn. *Rev. sci. Instrum.*, **25**, *No.* 9, 888–91 (*Sept.*, 1954).

An amplifier is described which is suitable for the amplification of signals from a radiation thermocouple used with a low-frequency interrupter. The system consists of a galvanometer which may be tuned by feedback over the range 1 to 3 c/s, followed by a tuned electronic amplifier covering the same range of frequency. The bandwidth of both elements may be varied. The output is presented as a rectified, smoothed deflection of the output meter. The amplification is sufficient to reveal thermal (Johnson) noise in the thermocouple circuit and is both linear in response and stable. A.

537.31

2718. Point source and sink in a parallelepiped. A. C. Sim and L. Lewin. Letter in *Nature* [*London*], **174**, 1155 (*Dec.* 18, 1954).

The potential distribution arising in this way is of importance in determinations of thicknesses of plates and of the conductivity of semiconductors. The analysis usually leads to a series involving a triple summation. A transformation is given, enabling the summations to be reduced to calculable form.

C. A. HOGARTH

537.31 : 530.162 : 621.317.74

2719. A spectrum analyser for the study of flicker noise. C. Manus, J. P. Borel and R. Mercier. *Helv. phys. Acta.*, **27**, *No.* 6, 497–502 (1954) In French.

A high-gain amplifier is described, tunable by LC networks to fixed frequencies in the range 100 c/s to 100 kc/s. The bandwidths obtainable vary from 2 c/s at the lower frequencies to ~ 100 c/s at high frequencies. The noise equivalent resistances of the input vary, from 27·5 kΩ at 100 c/s, asymptotically to ~ 2 kΩ at high frequencies. Noise voltages of the order of 0·01 μV can be measured. D. G. AVERY

537.31 : 536.7

On the thermomechanics of electrical conduction. *See Abstr.* 2693

537.31 : 621.376.23

2720. Spectral response of a quadratic device to non-Gaussian noise. T. A. Magness. *J. appl. Phys.*, **25**, *No.* 11, 1357–65 (*Nov.*, 1954).

In order to compute the spectral response of a quadratic device to noise, a fourth-order moment P of the input noise is sufficient, P being a function of three independent time delays. The function P_1 by which this fourth moment for a non-Gaussian noise differs from the corresponding moment for a Gaussian noise having the same spectrum is examined. The Fourier transform of this function is Q_1, a function of three frequencies. Q_1 is capable of an interpretation in terms of nonlinear correlations between noise components at different frequencies. A specialization of Q_1 leads to E, a function of two frequencies which is a measure of the correlation between the squares of the envelopes associated with those frequencies. Several networks involving quadratic nonlinear elements are examined to illustrate the theory. It is shown that while the function P makes it possible to compute the complete spectral response of the network, the function E (together with the spectrum of the input) is sufficient in order to find the spectral density at zero frequency. Finally, for three examples of non-Gaussian processes, the corresponding P_1, Q_1 and E functions are computed. A.

537.311.1 : 539.11

2721. Recombination processes in insulators and semiconductors. A. Rose. *Phys. Rev.*, **97**, *No.* 2, 322–33 (*Jan.* 15, 1955).

The discrete states in the forbidden zone are divided into ground states and shallow trapping states. The major recombination traffic passes through the ground states. The shallow trapping states cause the observed decay time of free carrier concentrations to exceed the lifetime of a free carrier in the conduction (or valence) band. At low rates of excitation (free carrier concentrations less than ground state concentrations)

the electron lifetime and hole lifetime are independent and, in general, significantly different. At high rates of excitation the free electron and hole lifetimes are equal. For an insulator having one class of ground states (a class being defined by the capture cross-sections for electrons and holes) the high-light lifetime is bracketed by the two low-light lifetimes. The behaviour of a model having one class of ground states can be described relatively simply and quantitatively. The behaviour of a model having more than one class of ground states becomes sufficiently complex for only special cases to be treated easily. More than one class of ground states, however, is required to account for infrared quenching, "superlinearity" and the ability of added ground states to reduce the rate of recombination. These phenomena involve a redistribution of electrons and holes amongst the classes of ground states. Such redistributions can give some meaning to the phrases: "filling of traps" or "saturation of centres." The recombination behaviour of a semiconductor is significantly different from that of an insulator. For example, superlinearity can occur in a semiconductor having only one class of ground states. Also, the photocurrents in a semiconductor can be intrinsically more noisy than the photocurrents in an insulator. A.

537.311.3 : 536.48 : 536.21

Electrical conductivities of solids at low temperatures. *See Abstr.* 2657

537.311.3 : 539.132

2722. Electrical conductivity of some condensed aromatic hydrocarbons. D. C. Northrop and O. Simpson. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, *Pt* 12, 892–4 (*Dec.*, 1954).

Describes measurements of the temperature dependence of conductivity for solid anthracene, naphthacene, pentacene and perylene, and solid solutions of the three latter in anthracene. The pure substances obeyed $\sigma = \sigma_0 \exp(-\varepsilon_0/2kT)$, σ_0 and ε_0 being constants for each substance, but for the solid solutions σ was that for pure anthracene above a critical temperature, but below it obeyed a similar law with constants σ_1 and ε_1 differing from those for pure solute or solvent. There is a correlation between ε_1 and the lowest singlet-triplet splitting in the free molecules. J. HAWGOOD

537.311.31

2723. Measurements of electrical conductivity and magnetoresistance of gray tin filaments. A. W. Ewald and E. E. Kohnke. *Phys. Rev.*, **97**, *No.* 3, 607–13 (*Feb.* 1, 1955).

A method for the preparation of grey tin filaments suitable for electrical measurements is described. Results of measurements of the temperature dependence of the electrical conductivity and of the magnetoresistance on pure grey tin and on alloys containing various amounts of Sb, As, In, Al and Zn are reported. For 99·998% pure tin the activation energy is 0·082 eV and the conductivity at 0°C is 2090 $\text{ohm}^{-1}\,\text{cm}^{-1}$. Addition of impurities results in an increase in the "intrinsic" activation energy and a decrease in the absolute value of the conductivity in the "intrinsic" range. Samples doped with *n*-type impurities exhibit a positive temperature coefficient of resistance at low temperatures whereas the low-temperature conductivity of *p*-type samples becomes temperature-independent at high impurity concentrations. The three *p*-type impurities In, Zn and Al show marked differences in their effectiveness in producing *p*-type conductivity, In being 40 times more effective than Al. The magnetoresistance coefficient in the lattice-scattering region shows a stronger temperature dependence than is predicted by the simple theory. Impurity scattering appears to be relatively more important in *p*-type than in *n*-type material. A.

537.311.31 : 536.48

2724. Irradiation effects in Cu, Ag, and Au near 10°K. H. G. Cooper, J. S. Koehler and J. W. Marx. *Phys. Rev.*, **97**, *No.* 3, 599–607 (*Feb.* 1, 1955).

Electrical resistivity increases produced by 12 MeV deuteron irradiation were measured as a function of integrated deuteron flux in Cu, Ag and Au. The bombardment temperature was near 10°K and no thermal recovery of the irradiation effects was observed; however, evidence that appreciable radiation annealing occurred during the bombardment was found. The resistivity increases near 10°K were much larger than those previously obtained in these metals for equal irradiations made near liquid nitrogen temperature. The observed Z-dependence of the irradiation effects agreed closely with that predicted by Seitz's theory. Warm-ups made following the bombardments revealed that 40 to 50% of the total resistivity increase in Cu recovers near 43°K and from 13 to 24% of that in Ag anneals near 30°K; the rapid recovery in each case indicates that a unique process may be involved, and the associated activation energy is estimated to be 0·1 eV for both. It is suggested that volume diffusion of interstitial atoms or annihilation of very close interstitial atom-vacancy pairs are two possible processes responsible for the low temperature recovery. In addition, for all three metals, a gradual annealing rate was observed in the intermediate temperature range 50°K–220°K, and then a more rapid rate took place in the range 220°–280°K. A.

537.311.31 : 539.23

2725. Electrical conductivity of thin films of metal. A. Blanc-Lapierre and M. Perrot. *Mem. Sci. phys.*, *No.* 57, 96 *pp.* (1954) In French.

A critical survey of experimental results and present theories limited to electrical conductivity with the direction of current flow parallel to the substrate but including materials which show semiconduction in the massive state. The optimum experimental conditions for producing suitable films are defined and some coefficients are introduced to facilitate discussion of the results. A bibliography concerned mainly with recent work contains 79 references. W. BARDSLEY

537.311.31 : 539.4.016.2

2726. Resistance and thermoelectric measurements of cold-worked copper and the resistance minimum at low temperatures. W. B. Pearson. *Phys. Rev.*, **97**, *No.* 3, 666–9 (*Feb.* 1, 1955).

Measurements of the change of residual resistance ratio of copper as a function of the percentage reduction in cross-sectional area by cold-working in liquid helium, liquid nitrogen or at room temperature and subsequent ageing treatments show (1) the

relative change of the ratio during recovery between 77°K and room temperature to that accompanying recovery and recrystallization at higher temperatures; (2) that there appears to be no recovery process taking place below 77°K; (3) that specimens cold-worked in liquid helium or nitrogen and aged at room temperature have a higher residual resistance ratio than specimens both cold-worked and aged at room temperature. The thermoelectric force, E, of copper specimens cold-worked at room temperature or liquid helium is positive relative to annealed copper in the range 4°–40°K (taking 4°K as zero). The measurements are discussed in relation to the origin of the electrical resistance minimum which is found in copper at 10°–14°K. A.

537.311.33

2727. The change of resistivity of NTC semiconductors with temperature. M. Varićak. *Period math.-phys. astron.* [*Zagreb*] **9**, *No.* 1, 59–63 (1954) In Serbo-Croat. Summary [200 words] in English.

Resistance–temperature measurements in the range 200–493°K on Philips thermally sensitive resistors. The results are expressed as

$$R = f(T) = 0{\cdot}603 \exp [3608/T]$$

The variation of the temperature coefficient of resistance is measured and varies from 9×10^{-2} at 273°K to $1{\cdot}5\times10^{-2}$ at 493°K. C. A. HOGARTH

537.311.33

2728. Experimental work on cyclotron resonance in semiconductors. A. F. Kip. *Physica*, **20**, *No.* 11, 813–17 (*Nov.*, 1954).

The experimental details of the cyclotron resonance experiments by which the effective masses of charge carriers in semiconductors have been determined are discussed. The semiconductors are measured at low temperatures to allow largest possible mean free path for the charge carriers. 1 cm microwave equipment is used. Charge carriers can be produced in some cases by radio-frequency ionization in the semiconductor samples. Circularly polarized microwaves resonating in a circular cylindrical cavity are used in the determination of the sign of the charge carriers. The microwave equivalent of a quarter-wave plate is used in the production of the circularly polarized microwaves. A.

537.311.33

2729. Surface properties of semiconductors. W. H. Brattain and C. G. B. Garrett. *Physica*, **20**, *No.* 11, 885–92 (*Nov.*, 1954).

The half-cell potential of a germanium-electrolyte interface has been measured as function of the current flowing across the surface and the light shining on the surface. The electrolytes used were N/10 solutions of HCl, KCl or KOH in H_2O. Except for an arbitrary constant and an "over voltage" the potential is equal to $(kT/e) \ln (x'/x)$; where x' and x are the actual and equilibrium carrier densities just inside the germanium surface. When germanium is anode, x is the hole density and when cathode, x is the electron density. These results and the previously published results on germanium gas interfaces can be understood in terms of a generalized theory of a *p-n* junction, one side of which (the body) is held constant in properties, while the other (the surface) is allowed to vary from extreme *p*-type to extreme *n*-type. Pictorially one may regard the surface as a discrete semiconducting phase, the properties of which may be changed by altering the chemical nature of the surface. A.

537.311.33

2730. Physico-chemical properties of diatomic crystals in relation to the incorporation of foreign atoms with deviating valency. F. A. Kröger and H. J. Vink. *Physica*, **20**, *No.* 11, 950–64 (*Nov.*, 1954).

If foreign ions of a valency deviating from that of ions of the base lattice are incorporated, electro-neutrality is maintained. This is effected in a number of ways, some of which are already known. For example, electro-neutrality may be maintained by the formation of vacancies, or by the occupation of interstitial sites. Koch and Wagner gave as an example of this mechanism the case of AgCl containing some $CdCl_2$. Another mechanism is that where the incorporation of the foreign ions is accompanied by a reduction or an oxidation of the base lattice, which prevents the formation of lattice imperfections. Here the compensation of charge is effected by the excess electrons or holes introduced in the lattice by the reduction or oxidation. It is shown that it is possible to consider the various ways of maintaining the electro-neutrality from a general point of view. There are a number of factors which govern the way the electro-neutrality can be maintained. Among these are the concentration of the foreign ions, the tendency of the base lattice to form lattice imperfections, the position of the energy levels associated with the various lattice imperfections, and the width of the forbidden zone. Another factor of importance is the atmosphere in equilibrium with the compound. In such a way a third mechanism of maintaining the electro-neutrality is found. Sometimes, for the same compound, two or three different mechanisms, depending on the composition of the surrounding atmosphere, may be found. It is explained how the manner of incorporation of foreign ions may differ for different base lattices. Application of these considerations to CdS as a base lattice gives a satisfactory agreement with experiment. A.

537.311.33

2731. Ground state of impurity atoms in semiconductors having anisotropic energy surfaces. M. A. Lampert. *Phys. Rev.*, **97**, *No.* 2, 352–3 (*Jan.* 15, 1955).

The nature of the ground state of a substitutional impurity atom in a crystal having an anisotropic energy-band structure is re-examined. A variational calculation has been made for the case of a band whose energy contours consist of several, symmetrically-located ellipsoids. Unlike the previous scalar, hydrogenic impurity model, this calculation at the outset uses the experimentally determined effective-mass-tensor components. Results for the impurity binding energy in germanium and silicon are of the order of 30% lower than those obtained directly from activation-slope measurements. Further, theoretical agreement with the experimentally determined critical impurity density for vanishing binding energy in germanium is much improved over the older model, though still not perfect. A.

537.311.33

2732. Effective carrier mobility in surface-space charge layers. J. R. SCHRIEFFER. *Phys. Rev.*, **97**, *No.* 3, 641–6 (*Feb.* 1, 1955).

Carriers held to a region near the surface by the potential well of a space-charge layer may have their mobility reduced by surface scattering, if the width of the well is of the order of a mean free path. An effective mobility, which may differ from the bulk mobility by as much as a factor of ten, has been obtained from a solution of the Boltzmann equation. Solutions have been carried out for two types of potential functions: (*a*) a linear potential corresponding to a constant space-charge field, and (*b*) a solution of Poisson's equation including an external bias applied normal to the surface. The results have been used to calculate changes in surface conductance of germanium with changes in surface potential and predict the "field effect" and "channel effect" mobilities. A.

537.311.33 : 537.312.5

2733. Electronic interpretation of inertia effects in barrier photocells (particularly internal capacity). G. BLET. *J. Phys. Radium*, **15**, *No.* 12, 823–8 (*Dec.*, 1954) In French.

Calculation of the transit time of photoelectrons through the rectifying barrier of the cell enables inertial effects previously attributed to capacity to be quantitatively explained. Internal resistance is assumed to depend on the variation in conductivity of the barrier with concentration of photoelectrons. A formula for dependence of time constant on electron concentration is established. G. F. J. GARLICK

537.311.33 : 539.11

2734. Electron distribution in semiconductors. M. TSUJI. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, *No.* 4, 106–8 (*March*, 1954).

Approximate theoretical discussion of the temperature dependence of the electron distribution in possible localized excited impurity levels below the conduction band. The Fermi level and the number of conduction electrons are calculated for Si for different numbers of discrete H-like levels and at different temperatures. The effect of the discrete excited levels is small, and negligibly so at very low temperature. J. HAWGOOD

537.311.33 : 548.7

2735. Scattering of electrons by charged dislocations in semiconductors. W. T. READ, JR. *Phil. Mag.*, **46**, 111–31 (*Feb.*, 1955).

Experiments suggest that dislocations in germanium act as rows of closely spaced acceptor centres. In *n*-type material a dislocation accepts electrons and becomes a line of negative charge surrounded by a cylindrical region of fixed positive space charge. An array of parallel dislocations will have relatively little effect on electron mobility parallel to the dislocations. The mobility normal to the dislocations will be reduced because: (1) The space charge cylinders deflect electrons and scatter the electron momentum normal to the dislocations; this reduces mean free time. Dislocation scattering is characterized by a mean free path that depends on direction. (2) Even when the dislocations are far enough apart that the mean free time is not affected, the macroscopic mobility may be reduced because the electrons cannot drift parallel to the applied field; instead they follow curved paths winding between the space charge cylinders (which in typical cases are the order of a micron in diameter). The paper deals with both drift and Hall mobility when the current flows normal to the dislocations and a magnetic field acts (1) parallel to the dislocations and (2) normal to the dislocations. A.

537.311.33 : 621.315.59

2736. A model showing current conduction in an *n*-type semiconductor. P. ROOD. *Amer. J. Phys.*, **23**, *No.* 2, 106–8 (*Feb.*, 1955).

The two distinct ways in which a current may be carried by an *n*-type semiconductor—by electrons and by "holes"—are illustrated by means of a model. It is the control of one type of current by the other which makes possible various forms of transistor action. A.

537.311.33

2737. The nature of the electrical contact by studies on single crystals of cadmium sulphate. II. W. M. BUTTLER AND W. MUSCHEID. *Ann. Phys.* [*Leipzig*] **15**, *No.* 2, 82–111 (1954) In German.

For Pt I, see Abstr. 8291 (1954).

537.311.33

2738. Controlled conductivity in CdS single crystals. F. A. KRÖGER, H. J. VINK AND J. VAN DEN BOOMGAARD. *Z. phys. Chem.* [*Leipzig*] **203**, *No.* 1–2, 1–72 (*May*, 1954).

The electrical and optical properties of single crystals of pure CdS or of CdS containing Ga, In, Sb, Cl or Ag are found to depend markedly on the composition of the atmosphere in which they are prepared. Crystals exposed to an oxidizing atmosphere (e.g. sulphur vapour) are insulators or semiconductors and show photoconductivity; those exposed to a reducing atmosphere show quasimetallic conductivity. In crystals containing Ga or Cl the concentrations of the charge carriers are equal to the respective concentrations of the foreign ions. Bands appear in the yellow region of the absorption spectrum of oxidized but not of reduced crystals. The theory of defect structures is extended to calculate the dependence of the concentration of defects (donors, traps, acceptors) on the concentration and nature of the impurities and the reducing power of the atmosphere. Satisfactory agreement with experiment is found. W. GOOD

537.311.33

2739. Some recent developments in the calculation of crystal energy bands—new results for the germanium crystal. F. HERMAN. *Physica*, **20**, *No.* 11, 801–12 (*Nov.*, 1954).

Among the techniques treated are the cellular method, the orthogonalized-plane-wave (OPW) method, and the augmented-plane-wave method. A recently completed calculation of the band structure of the germanium crystal by the OPW method is described. It is found that the band structure obtained depends quite critically upon the assumed crystal potential. The structure of the top of the valence band, which lies at the central point of the reduced zone, is strongly influenced by spin-orbit interaction and by

the proximity of the lower conduction bands. The crystal eigensolutions belonging to the two lowest conduction bands converge at different rates and respond in different ways to arbitrary changes in the crystal potential. The latter fact is used as the basis for an interpretation of certain optical properties of germanium–silicon alloys. The solution indicates that the lowest conduction band had a well-defined minimum at the central point of the reduced zone. If the solution were carried to a higher-order approximation, one would expect to find the minimum of this conduction band at positions along the [111] axes rather than at the central point of the zone. The next-to-the-lowest conduction band has six minima along the [100] axes. In proceeding from pure germanium to pure silicon through intermediate compositions of Ge–Si alloys, the states normally occupied by electrons shift from the [111] minima to the [100] minima. A.

537.311.33

2740. Anisotropy of cyclotron resonance in germanium. B. Lax, H. J. Zeiger and R. N. Dexter. *Physica*, **20**, *No.* 11, 818–28 (*Nov.*, 1954).

The effective masses of holes and electrons have been measured by means of cyclotron resonance experiments as a function of crystal orientation. The measurements were made at 4·2°K at 8900 and 23 000 Mc/s using infrared illumination of the crystals. The results are consistent with a model for the bottom of the conduction band in which the energy surfaces in the Brillouin zone consist of eight ellipsoids of revolution along the [111] axes. From the experiments it was deduced that the longitudinal mass $m_1 = 1{\cdot}4\, m_0$ and the transverse mass $m_2 = 0{\cdot}083\, m_0$, where m_0 is the free electron mass. Two peaks were observed for holes corresponding to effective masses m_1^* and m_2^*. m_1^* was nearly isotropic at $m_1^* = 0{\cdot}042\, m_0$. m_2^* showed an anisotropy given approximately by

$$m_2^* \simeq m_0[0{\cdot}357 - 0{\cdot}017(1 - 3\cos^2\theta)^2],$$

where θ is the angle between the [001] direction and the magnetic field in the (110) plane. The results are consistent with a model for the constant energy surfaces in the Brillouin zone at the top of the valence band, consisting of two sets of surfaces, for which the energy, ε, as a function of the wave vector $\mathbf{k}$ is:

$$\varepsilon = (-\hbar^2/2m_0)\{13{\cdot}6k^2 \pm \sqrt{[146k^4 - 63\,(k_x^4 + k_y^4 + k_z^4)]}\}$$ A.

537.311.33

2741. Experimental evidence on the band structure of germanium and silicon. C. Kittel. *Physica*, **20**, *No.* 11, 829–33 (*Nov.*, 1954).

Reviews the status of experiments bearing on the band structure of semiconductors, with particular reference to germanium and silicon. The situation in *n*-Ge is especially clear, as both cyclotron resonance and magnetoresistance experiments show that the energy surfaces at the bottom of the conduction band are prolate spheroids oriented along the [111] directions in *k*-space; the spheroids are highly anisotropic, with a mass ratio of about 15 : 1. In *p*-Ge the two isotropic lines in cyclotron resonance suggest that the band edge is at the centre of the Brillouin zone; the multiplicity is explained by spin-orbit splitting. It appears that this model may account, qualitatively, for the remarkable infrared absorption of *p*-Ge, but it seems to be difficult to explain transport data. From magnetoresistance and from cyclotron resonance it is found that the energy surfaces in *n*-Si are prolate spheroids directed along [100] axes, while the structure of *p*-Si is like *p*-Ge. A.

537.311.33

2742. The electrical properties of germanium semiconductors at low temperatures. H. Fritzsche and K. Lark-Horovitz. *Physica*, **20**, *No.* 11, 834–44 (*Nov.*, 1954).

Low-temperature anomalies in the Hall effect—a steep maximum—and a change of the slope of the log resistivity *v.* $1/T$ curve in germanium semiconductors, which were first observed by Hung and Gliessman, have been re-investigated using single crystals of *n*- and *p*-type germanium of various carrier concentrations. By using cross-shaped samples, the influence of contacts was investigated. To estimate the effect of surface layers, various surface treatments have been tried and the ratio of surface area to bulk volume has been changed. It was found that the effects cannot be explained by surface conduction. To exclude electrical field effects at low temperatures (to about 1·50°K), fields as low as 3 mV/cm, well below breakdown field, have been used. The Hall effect was measured with varying magnetic fields ranging from 200 to 4300 gauss. In the same temperature region where Hall effect and resistivity become anomalous, the magneto-resistive ratio also shows drastic changes. In the temperature range before the Hall maximum is reached the magneto-resistive ratio changes only slowly with temperature, but starts to decrease sharply at the temperature where the Hall effect approaches the maximum and where the resistivity curve changes slope. The discussion of the results indicates that the observations can be described by a model which assumes conduction in two bands, the regular conduction band (valence band in the case of *p*-type material) and a band with a very small mobility. The sharp decrease of this mobility with decreasing impurity content suggests that conduction in an impurity band is a plausible explanation of these phenomena. A.

537.311.33

2743. Impurity centers in Ge and Si. J. A. Burton. *Physica*, **20**, *No.* 11, 845–54 (*Nov.*, 1954).

A review is given of recent experimental work on the chemical and electronic properties of impurity centres in germanium and silicon. The distribution co-efficients, solubilities, diffusion coefficients, ionization energies and capture cross-sections of solute elements are discussed. The properties of the Group III acceptors and Group V donors are compared with those for elements from other regions of the periodic table. A.

537.311.33

2744. Recombination and trapping of carriers in germanium. H. Y. Fan, D. Navon and H. Gebbie. *Physica*, **20**, *No.* 11, 855–72 (*Nov.*, 1954).

The dependence of carrier lifetime on temperature has been investigated for *n*-type and *p*-type germanium. It is found that with decreasing temperature the

lifetime decreases, but much faster in *n*-type than in *p*-type. The results are discussed in terms of recombination through trapping states. At sufficiently low temperatures photoconductivity and carrier injection experiments show signs of minority carrier trapping in *n*-type samples and occasionally in *p*-type samples. The phenomena observed are discussed and the properties of the trapping states are deduced. These particular trapping states are shown to be not the major cause of recombination. Doping with copper or thermally quenching *n*-type samples gives rise to trapping as well as enhances recombination. In comparison, thermal quenching can produce more effect on the lifetime with less effect on the sample resistivity. A.

537.311.33

2745. Measurement of carrier lifetimes in germanium and silicon. D. T. Stevenson and R. J. Keyes. *J. appl. Phys.*, **26**, *No.* 2, 190–5 (*Feb.*, 1955).

The decay of photoconductivity has been used to measure the lifetime of excess carriers in rectangular samples of germanium and silicon. The sample is illuminated by a short pulse of light and the sample lifetime obtained from an oscilloscope display of the decay of photoconductivity. Analysis of the solution of the diffusion equation yields methods of measuring the bulk lifetime, the surface recombination velocity and the diffusion constant. A.

537.311.33

2746. Gold as an acceptor in germanium. W. C. Dunlap, Jr. *Phys. Rev.*, **97**, *No.* 3, 614–29 (*Feb.* 1, 1955).

Results are presented and discussed concerning the effects of gold in germanium, measured by means of Hall effect, resistivity, photoconductivity, diffusion, heat treatment and other techniques. It is shown that gold is an acceptor having high-lying states unlike those of the ordinary impurity elements. Evidence is presented to show that each gold atom produces two such levels, one at 0·15 eV above the valence band, the other 0·2 eV below the conduction band. It is assumed that these are brought about through the formation of Au^- and Au^{--}. The implications of this model are discussed. Depending upon the relative proportions of gold atoms and other donors and acceptors, the gold-doped samples may be either high- or low-resistance, *p*- or *n*-type at 77°K. The resistivity may be as high as 10^8 ohm-cm at this temperature. The segregation coefficient, measured from the electrical properties, was about $1{\cdot}5\times10^{-5}$. The solubility of gold in germanium is about 10^{15} atoms/cm^3. Photoconductivity studies confirm several features of the model proposed. In particular, gold-doped germanium has been shown to be an infrared photoconductor with response out to about $8\,\mu$. A number of interesting trapping phenomena have been observed with gold-doped germanium. The diffusion coefficient of gold into germanium was measured. It is about 4×10^{-9} cm^2/sec at 900°C, with activation energy of about 2·5 eV, the same as found for other elements. Gold-doped germanium has been studied as a function of heat-treatment (copper diffusion). Several anomalous results are discussed. Gold-doped germanium has also been studied at low temperatures, for the purpose of detecting scattering by doubly charged impurity ions. The results were inconclusive in deciding whether or not doubly charged Au^{--} ions were present. Also results on the scattering of neutral gold atoms were obtained. The Fermi statistics for gold-doped germanium are considered, and theoretical curves have been obtained for the temperature variation of the Fermi level, and of the Hall coefficient, under various conditions of gold-doping. Agreement of experimental and theoretical results was found to be fair. A discussion is also given of the applications of gold-doped germanium to research on other problems. A.

537.311.33

2747. Properties of germanium doped with cobalt. W. W. Tyler, R. Newman and H. H. Woodbury. *Phys. Rev.*, **97**, *No.* 3, 669–72 (*Feb.* 1, 1955).

Measurements of the temperature dependence of electrical resistivity in *n*- and *p*-type cobalt-doped germanium crystals indicate that cobalt introduces acceptor levels in germanium at $0{\cdot}31 \pm 0{\cdot}01$ eV from the conduction band and $0{\cdot}25 \pm 0{\cdot}01$ eV from the valence band. Ionization energies deduced from infrared photoconductivity studies at 77°K are in good agreement with the values obtained from resistivity measurements. *N*-type samples show higher intrinsic photosensitivity than *p*-type samples and demonstrate quenching effects. A.

537.311.33 : 538.223

2748. An interpretation for the electronic conductivity and diamagnetic susceptibility of graphite. K. Ariyama and S. Mase. Letter in *Progr. theor. Phys.*, **12**, *No.* 2, 246–8 (*Aug.*, 1954).

See Abstr. 2915 (1955). Discusses effect on the anisotropy of these properties of stacking disorder, of scattering at crystal boundaries and of the form of the energy bands. J. HAWGOOD

537.311.33

2749. Hall effect and electrical conductivity of lead selenide. E. Hirahara and M. Murakami. *J. Phys. Soc. Japan*, **9**, *No.* 5, 671–81 (*Sept.–Oct.*, 1954).

Electrical conductivity and Hall constant of both *p*-type and *n*-type specimens were measured over the temperature range from 500°C to −180°C. The complicated properties of *p*-type specimens were fairly well analysed by taking into consideration scattering from both lattice and impurity centres and the temperature dependence of Fermi energy. The agreement between the calculated and measured values of conductivity and Hall constant at any temperature was satisfactory. The Fermi energies of impurity semiconductors in which both electrons and holes act as current carriers were calculated, and the errors in the approximate calculation of Fermi energy were discussed. A.

537.311.33 : 548.7

2750. Trapping of minority carriers in silicon. I. *P*-type silicon. J. A. Hornbeck and J. R. Haynes. *Phys. Rev.*, **97**, *No.* 2, 311–21 (*Jan.* 15, 1955).

Experimental evidence of temporary trapping of electrons in the volume of *p*-type silicon in two different traps is presented. The evidence is shown to lead to a multiple trapping model the kinetics of

which explain the data. The trap parameters are determined by the fit of experimental data to the theory. The trap density; energy level, cross-section for capture, S, and the time which an electron spends in a trap, τ_g, are determined for both traps. For the deeper traps, $S\tau_g$, a property of the trap itself, is shown to have the probably value $0{\cdot}81 \pm 0{\cdot}25 \times 10^{-13}$ cm^2 sec with $\tau_g \simeq 0{\cdot}3$ sec for all specimens examined. In low-resistivity crystals there is evidence for a loss mechanism for electrons (recombination) from the deeper traps at a rate found proportional to the square of the hole concentration. The deep-trap concentration is found to be roughly proportional to the sample conductivity. A.

537.311.33 : 548.7

2751. Effect of crystal distortion upon change of resistivity of silicon by heat treatment. W. C. Dash. *Phys. Rev.*, **97**, *No.* 2, 354 (*Jan.* 15, 1955).

Silicon crystals grown by the Teal–Little method under certain conditions change resistivity upon heat treatment at about 450°C, becoming more *n*-type. When crystals of this type are bent at 1100°C and quenched, heat treatment at 450°C indicates that the distorted regions are more stable than undistorted regions. This suggests that structural defects retard the appearance of *n*-type carriers and may be responsible for variations among samples grown under different conditions. A.

537.311.33

2752. Titanium nitride and titanium carbide as semiconductors. A. Münster, K. Sagel and G. Schlamp. Letter in *Nature* [*London*] **174**, 1154–5 (*Dec.* 18, 1954).

TiN usually behaves as a metal, but if layers (1 to 25 μ thick) are deposited on quartz, semiconducting properties are observed. Similar behaviour is found for titanium carbide, and for mixed crystals of the two materials. C. A. HOGARTH

537.311.33

2753. The temperature dependence of zero bias resistance of metal rectifiers. H. Tubota, H. Suzuki and A. Okazaki. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, *No.* 4, 109–12 (*March*, 1954).

Measurements are made of the zero bias resistance of Cu_2O and Se rectifiers over the temperature range 250–550°K. Deductions are made from the results concerning the temperature-dependence of carrier mobilities, and these values agree with other results provided that correct values for the barrier heights in the rectifiers are chosen. D. G. AVERY

537.311.33

2754. Temperature dependence of diffusion potential of metal rectifiers. H. Tubota, Y. Matukura and A. Okazaki. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, *No.* 4, 127–30 (*March*, 1954).

The diffusion potentials of Se and Cu_2O rectifiers have been determined over the range 260°K to 440°K from measurements of the linear part of their forward characteristics. The temperature variation of the Fermi level has been calculated, assuming various impurity concentrations, but no agreement between the calculated dependence of the Fermi level and the observed dependence of the diffusion potential was found. It is suggested that the discrepancy may be due to heating of the rectifier during measurement, although a pulse method was employed. D. G. AVERY

537.311.33

2755. Surface leakage current in rectifiers. M. Cutler and H. M. Bath. Letter in *J. appl. Phys.*, **25**, *No.* 11, 1440–1 (*Nov.*, 1954).

A surface leakage current is added to the normal diode theory current and the results agree well with experiment. The surface leakage current arises by flowing through the surface film with an ohmic voltage drop and across the surface barrier. C. A. HOGARTH

537.311.33

2756. Semiconductor devices made with single crystal germanium–silicon alloys. R. A. Logan, A. J. Goss and M. Schwartz. Letter in *J. appl. Phys.*, **25**, *No.* 12, 1551–2 (*Dec.*, 1954).

By choosing alloys of the appropriate composition the operating temperature advantages of Si and the good electrical characteristics of Ge can both be retained. Diffusion techniques are most suited to making junction devices, and typical data for diodes and transistors ($\alpha > 0{\cdot}9$) are given. C. A. HOGARTH

537.311.33 : 537.312.5

2757. Long period effects in germanium crystal rectifiers. M. Kikuchi. *J. Phys. Soc. Japan*, **9**, *No.* 5, 665–70 (*Sept.–Oct.*, 1954).

Long-period phenomena in germanium diodes, i.e. "creep" and "creep of photocurrent," have been observed. These phenomena have close connection with the "photo-after-effect" previously reported [Abstr. 6614 (1954)]. It is proposed to take trapping levels into account to explain these three related phenomena consistently. Although the time constants observed in these experiments, as long as 30–50 sec or 200–300 sec, may seem too large to be attributed to the traps, this model is thought to be the most suitable for the treatment of such long-period effects in crystal rectifiers. A.

537.311.35

2758. A note concerning the conductivity of liquid dielectrics. J. Hart and D. A. Simmons. *Canad. J. Phys.*, **33**, *No.* 2, 54–7 (*Feb.*, 1955).

Experiments are described which show that it is not permissible to ignore electrode effects in the calculation of the mobilities of ions in liquid dielectrics. Preliminary results indicate that the fall in direct current with time is due partly to electrode polarization, and partly to the removal of ions from the liquid. It has been found that for apparent field strengths lower than 1 kV/cm the current in the dielectric is proportional to the applied potential, and there appears to be a back-e.m.f. of about one volt. Precautionary measures are suggested for future experiments. A.

537.311.35 : 539.213

2759. On the electrical conductivity of glasses. I. The conductivity of mixed glasses. B. Lengyel and Z. Boksay. *Z. phys. Chem.* [*Leipzig*] **203**, *No.* 1–2, 93–112 (*May*, 1954) In German.

With a view to explaining the occurrence of a maximum in the electrical resistance of a mixed glass, in which there exist two kinds of mobile cations, as its composition is varied, a model is set up in which

the geometrical restriction confronting an ion of larger diameter about to pass through the vacancy of an ion of smaller diameter is taken into account. The equations obtained for the conductivity and transport numbers of the two ions give values in good agreement with experiment. W. GOOD

537.311.37 : 541.126 : 534.222.2

On electrical conductivity in detonation and shock waves. *See Abstr.* 2513

537.312.5

2760. On silver bromide photocells. H. AMSLER. *Dissert. E.T.H. Zurich, Paper* 2280, 35 *pp.* (1953) In German.

Detailed descriptions are given of (1) the preparation of cells by electrolytic bromination of a silver plate followed by evaporation of semi-transparent silver on top; (2) mounting the cells; (3) the optical arrangements for irradiation with selected regions of the mercury spectrum or of an incandescent source; (4) the detector system, including a galvanometer relay with sensitivity of 10^{-11} A; (5) the determinations and calculations involved in the quantum efficiency. The cells vary in resistance from 0·5 to 60 000 ohm, which is independent of the irradiation intensity. The short-circuit current is independent of the internal resistance, but proportional to the irradiation intensity. For 3650 Å radiation the quantum efficiency approaches unity in some cases but depends on the thickness of the evaporated Ag layer. The spectral sensitivity may be increased in the longer wavelength visible region by incorporation of AgI in the AgBr layer, or by sensitizing dyes, the effects resembling those in photographic emulsions. Irradiated cells show a slow rise of current to the steady value over several minutes, and a similar decay. Cells treated with $NaNO_2$ before evaporating on the Ag show a transitory reverse e.m.f. (evaporated Ag layer negative instead of the usual positive) at the start of both illuminated and dark phases. The cell mechanism is discussed at length. S. T. HENDERSON

537.312.5

2761. Study of the physical properties of thin-layer photo-elements of cadmium sulphide. G. WLÉRICK AND F. PRÉGERMAIN. *J. Phys. Radium*, **15**, *No.* 11, 757–64 (*Nov.*, 1954) In French.

537.312.5

2762. InSb photovoltaic cell. G. R. MITCHELL, A. E. GOLDBERG AND S. W. KURNICK. Letter in *Phys. Rev.*, **97**, *No.* 1, 239–40 (*Jan.* 1, 1955).

A *p-n* junction was made during the pulling process. Properties of the junction as a photovoltaic detector were measured at 77°K. The spectral response was to 5·7 μ; the response time was less than 2 μsec.

C. A. HOGARTH

537.312.5 : 535.345

Relation of antimony optical transmission and the photoelectric yield of Cs–Sb. *See Abstr.* 2610

537.312.5 : 537.311.33

2763. Photoconductivity of cadmium sulphide. H. FRANK. *Slaboproudý Obzor*, **15**, *No.* 8, 371–7 (1954) In Czech.

Internal photoelectric effect in crystals is explained, it being pointed out that photoconductivity can take place only when the absorption of light by crystals results in the appearance of free electrons. The photoconductivity of crystalline CdS is explained by means of the energy-band model proposed by Riehl–Schön. The large quantum yield (10^4 electrons/photon) observed in CdS is due to an immediate capture of holes by the activator levels. Photoelectric current in CdS crystals shows a considerable inertia, this being caused by mono- or bi-molecular, or combined recombination of the electrons and holes. A mathematical theory of this effect is presented, describing both the rise and decay of the photoconductivity. The paper is illustrated by a number of experimental curves taken from various sources.

R. S. SIDOROWICZ

537.312.5 : 537.311.33

2764. Photoconductivity and crystal imperfections in cadmium sulfide crystals. I. Effect of impurities. R. H. BUBE AND S. M. THOMSEN. *J. chem. Phys.*, **23**, *No.* 1, 15–18 (*Jan.*, 1955).

The conductivity and photosensitivity of CdS crystals can be controlled by the incorporation of suitable impurities. The conductivity and photosensitivity are increased by the incorporation of a halide or a trivalent cation, and decreased by the incorporation of copper or silver. A possible mechanism by which such impurities may produce the observed effects on the photoconductivity is presented.

A.

537.312.5 : 537.311.33

2765. Photoconductivity and crystal imperfections in cadmium sulfide crystals. II. Determination of characteristic photoconductivity quantities. R. H. BUBE. *J. chem. Phys.*, **23**, *No.* 1, 18–26 (*Jan.*, 1955).

From measurements of photoconductivity on low-conductivity "pure" CdS single crystals, and on high-conductivity cadmium sulphide crystals with chloride impurity, values for the following characteristic photoconductivity quantities have been obtained: (1) concentration of levels in the forbidden gap, (2) energy distribution of such levels, (3) attempt-to-escape frequency for electrons in traps, (4) capture cross-section of traps, (5) capture cross-section of recombination centres, (6) mobility for electron charge carriers, and (7) binding energy for the electron held in an orbit around the chloride ion in conducting crystals. A.

537.312.5 : 548.7

2766. Capacitance and conductance effects in photoconducting alkali halide crystals. J. R. MACDONALD. *J. chem. Phys.*, **23**, *No.* 2, 275–95 (*Feb.*, 1955).

Measurements of the a.c. and d.c. response of illuminated *F*-centred potassium bromide single crystals have been carried out. The dependence of crystal capacitance and conductance on frequency, light intensity, electrode character and separation, *F*-centre concentration, applied voltage, temperature and optical bleaching time have been investigated. Most of the measurements were made on crystals containing both *U* and *F* centres, but a few were also made on additively coloured and plain untreated crystals for comparison. It was found that *F* centres in *U*-centred crystals bleached much slower under strong illumination than did those in additively

F-centred crystals. The frequency response of the crystals depended significantly upon whether the electrodes were blocking or rectifying, but in both cases it was characterized by a single relaxation time given by the quotient of a series capacitance C_0 and G_∞, the normal conductance of the crystal. C_0 was found to be independent of all variable parameters except dark storage and bleaching time and is thought to arise from a charge-free layer located at one or both electrodes. Space-charge capacitance effects were apparently largely hidden by C_0 but did probably produce a small voltage-dependent nonlinearity observed at low frequencies with high applied voltages. G_∞, and thus the conduction-band electron concentration, depended linearly on light intensity over a wide range but underwent a transition from linear dependence on *F*-centre concentration to independence thereof at high concentrations. Partly bleached crystals in total darkness exhibited appreciable conductivity, probably electronic in character. Most of the results on *U*-centred crystals can be tentatively explained in terms of electron trapping by negative-ion vacancies, *F* centres, interstitial hydrogen atoms, and hydrogen atoms in negative-ion vacancies. A.

537.312.62

2767. Effects in superconductors at the transition normal conductivity–superconductivity. W. Meissner. *Naturwissenschaften*, **41**, *No.* 19, 437–40 (1954) In German.

Continuation of experiments on the increase, in the transition region, of the longitudinal flux in wires which carry a current and are placed in an external longitudinal magnetic field [Abstr. 1646 (1953)]. The resistance R is measured simultaneously with the flux ϕ. With falling temperature R and ϕ change simultaneously in steps, which are sometimes in opposite direction to the main trend. The results give further support to the explanation that the increased flux is due to helical superconducting threads (parallel to the resultant magnetic field) which cause the current to follow a similar path. H. London

537.32 : 541.134

2768. Thermodiffusion potentials in electrolytes. Initial thermodiffusion potentials. J. Chanu. *J. Chim. phys.*, **51**, *No.* 7–8, 390–9 (*July–Aug.*, 1954) In French.

An analysis based on analogy with thermoelectricity in metals has been made, to derive an expression for the potential difference between two electrodes immersed in hot and cold parts of a solution of a uni-univalent electrolyte without convection, and when Soret equilibrium is established. Measurements with Ag/AgCl half-cells in NaCl and KCl have revealed an almost strictly linear variation of $\Delta\Phi$ with $\Delta T(\Delta\Phi = \text{p.d.})$; $\Delta\Phi/\Delta T$ decreases slightly when the concentration increases, indicating that the mean ion transfer entropy is negative. Individual ion transfer entropies cannot be calculated from such measurements. R. C. Murray

537.323

2769. Thermoelectric behavior of nickel oxide. G. Parravano. *J. chem. Phys.*, **23**, *No.* 1, 5–10 (*Jan.*, 1955).

Measurements have been made on the thermoelectric power of several nickel oxide samples containing foreign ions. Using an energy model recently proposed for nickel oxide, the effect of the nature and concentration of additions on the Fermi level, hole concentration and mobility is derived and discussed. For most of the samples hole concentration can be related to chemical composition. A case of change in valence of the addition induced upon introduction into the matrix is found. The use of the thermoelectric effect to determine impurity in nickel oxide is discussed. The energy scheme of nickel oxide which emerges from this work and that of Morin is emphasized as a drastic departure from the classical model of an electrical semiconductor. A.

ELECTRIC DISCHARGES 537.52

537.52

2770. Gaseous electronics. Conference in New York. F. Llewellyn Jones. *Nature* [*London*] **175**, 154–5 (*Jan.* 22, 1955).

Short report of the papers read at the conference sponsored by the American Physical Society, October, 1954.

537.523.4

2771. On the significance of channel formation in [electrical] breakdown of air. W. Köhrmann and H. Raether. Note in *Naturwissenschaften*, **41**, *No.* 17, 400–1 (1954) In German.

Briefly discusses the criterion for formation of a canal discharge (streamer) in air determined by the establishment in the avalanche head of a critical space-charge field. New breakdown voltage data (e.g. 30·2 kV breakdown voltage in air for a 1 cm uniform field gap) require that the critical pd (pressure × gap length) value should be higher than previously thought; $\alpha d - pd$ curves are given for various overvoltages. J. D. Craggs

537.523.4 : 621.3.015.5

2772. Formative time-lag studies with high-frequency discharges. A. W. Bright and H. C. Huang. *Proc. Instn Elect. Engrs, Monogr. No.* 105 R, publ. *Aug.* 16, 1954 (**102 C**, 42–5).

For abstract see Abstr. 10208 (1954).

537.523.5 : 538.561

2773. Radiation of plasma noise from arc discharge. T. Takakura, K. Baba, K. Nunogaki and H. Mitani. *J. appl. Phys.*, **26**, *No.* 2, 185–9 (*Feb.*, 1955).

The mechanism of radiation of plasma noise inherent to arc discharge is studied experimentally. Intense electromagnetic radiation of random noise character is observed at the frequency of plasma oscillation of the ion sheath formed at the cathode drop. Maximum radiation occurs when the external circuit connected to the cathode is in resonance with the plasma frequency. The oscillating current in the external circuit is concluded to be generated by the periodic electron emission from the cathode caused by small perturbation of potential gradient at the cathode surface as a result of the variation in the ion sheath potential. This conclusion is supported by several experiments under various air pressures, electrode materials, current densities, etc. A.

537.525.3 : 537.525.72 : 537.525.8

2774. On the observed reversal of Joshi effect on exposure to light with increasing intensity. C. M. SRIVASTAVA. Letter in *J. sci. industr. Res.*, **13 B**, *No.* 10, 737–9 (*Oct.*, 1954).

A brief discussion of effects due to adsorbed layers and space charges in ozonizer corona tubes, with special reference to the sign of the Joshi effect (change of corona current due to external illumination).

J. D. CRAGGS

537.525.4

2775. "Threshold potential" of the a.c. electrodeless discharge. S. R. MOHANTY. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2095–6 (*Dec.*, 1954).

Discusses a modified Townsend criterion for gaseous breakdown when dielectric (insulating) surface is exposed to the discharge region. J. D. CRAGGS

537.525.5 : 537.525.8

2776. The kinetic theory of feebly ionized homogeneous plasmas. I. M. BAYET, J.-L. DELCROIX AND J.-F. DENISSE. *J. Phys. Radium*, **15**, *No.* 12, 795–803 (*Dec.*, 1954) In French.

A general theoretical study of a plasma in superimposed electrical and magnetic fields. The treatment involves a study of electron energy distributions from a development of the Boltzmann plasma equation. The electrical conductivity coefficients, for each of three dimensions, are derived and this leads in one case to the Hall-effect formula. J. D. CRAGGS

537.525.8

2777. Effect of moving striations on microwave conductivity of a coaxial discharge. H. L. STEELE, JR AND P. J. WALSH. Letter in *J. appl. Phys.*, **25**, *No.* 11, 1435–6 (*Nov.*, 1954).

Describes how moving striations affect the absorption of 10 cm wavelength radiation in a low-pressure discharge, suitably arranged in a coaxial transmission line. J. D. CRAGGS

537.525.8

2778. Space charge effects in high-frequency discharges. I. M. CHENOT. *J. Phys. Radium*, **16**, *No.* 1, 54–61 (*Jan.*, 1955) In French.

Describes a study of discharges excited, at frequencies $\sim$ 37 to 50 Mc/s, with external electrodes, in which a superimposed steady current is passed. Current-voltage characteristics, and related phenomena, are discussed. Experimental details are given.

J. D. CRAGGS

537.528 : 541.67

2779. Electric strength and molecular structure of saturated hydrocarbon liquids. R. W. CROWE, A. H. SHARBAUGH AND J. K. BRAGG. *J. appl. Phys.*, **25**, *No.* 12, 1480–4 (*Dec.*, 1954).

A number of investigators have reported that the apparent electric strengths of straight-chain hydrocarbon liquids increase in a regular manner with increasing molecular chain length. Abstr. 4568 (1954) presented evidence that this phenomenon is an illustration of a kind of Paschen's law for liquids. An observed linear dependence of the electric strengths of such hydrocarbons upon density suggested that chain length variation merely provided a means of changing the electron mean free path in the liquid. The present paper describes the development of an improved technique for measuring electric strengths of liquids, and the application of this technique to a series of pure straight-chain and branched-chain liquid alkanes. As had been observed previously, the strengths of the straight-chain members of the series exhibit a linear relationship with density. The introduction of branches into the hydrocarbon chain, however, results in a definite decrease in strength. Extension of the measurements to hydrocarbons of more complicated structure has apparently introduced a kind of fine structure. Measurement of the time-dependence of electrical breakdown in liquid hydrocarbons shows that the formative time lag is relatively insensitive to changes in viscosity or molecular weight. For an electrode separation of 0·002 in., it is approximately one μsec. A.

X-RAYS 537.531

537.531 : 535.343

2780. A formula for the *K*- and *L*-absorption discontinuities. B. K. AGARWAL. Letter in *Curr. Sci.*, **23**, *No.* 11, 357 (*Nov.*, 1954).

Empirical *K*-absorption jump ratios are compared. Rindfleisch's ratio is derived from the general atomic absorption coefficient. J. J. PHIPPS

537.531 : 535.343

2781. *L*-spectrum of plutonium. Y. CAUCHOIS, I. MANESCU AND F. LE BERQUIER. *C.R. Acad. Sci. [Paris]* **239**, *No.* 25, 1780–2 (*Dec.* 20, 1954) In French.

The preparation and use of homogeneous Pu^{239} sources from a 10 mg PuO_2 sample from the Châtillon pile is described. The three *L*-absorption discontinuities were sharply resolved and measured. A modification permitted comparison of the X-ray fluorescence of Pu^{239} with that of other sources, with experimental errors of 2 eV. This method may be extended to other transuranic elements. J. J. PHIPPS

537.531 : 535.376

2782. The *M* X-ray from radium D and the *M* X-ray fluorescence yield of bismuth. A. A. JAFFE. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 316–20 (*March*, 1954; publ. *June*, 1954).

Using a proportional counter the rather low-intensity *M* X-rays from a RaD source have been measured. The estimated *M* fluorescence yield from RaE is given as 0·037 $\pm$ 0·007 compared with 0·06 for uranium [M. Lay, *Z. Phys.*, **91**, 553 (1934)].

G. F. J. GARLICK

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

2783. Experimental studies of betatron orbit stability. G. C. BALDWIN, F. R. ELDER AND W. F. WESTENDORP. *J. appl. Phys.*, **25**, *No.* 12, 1553–4 (*Dec.*, 1954).

A magnet has been built for a small betatron in which $n = -(r/B)(\partial B/\partial r)$ can be varied from 0·5 to 0·9, the equilibrium orbit radius being 5·25 in.

Relative X-ray output with and without shifting of the orbit to strike an internal target is measured as a function of n. With the orbit shift the output rises gradually by about a factor 2 from $n = 0{\cdot}5$ to $n = 0{\cdot}75$. The output then drops abruptly to zero till $n = 0{\cdot}83$ beyond which it rises to nearly the $n = 0{\cdot}5$ value. J. H. FREMLIN

537.533

2784. Synchrotron oscillations induced by radiation fluctuations. M. SANDS. *Phys. Rev.*, **97**, *No.* 2, 470–3 (*Jan.* 15, 1955).

Phase oscillations of electrons in a high-energy synchrotron are induced by the radiation of quanta. These induced oscillations set a limit to the damping of electron bunches. This limiting bunch size is sufficient to influence the radial aperture and the radio-frequency voltage required at low beam intensities, and to reduce energy loss by coherent radiation at high intensities. A.

537.533.35

2785. Errors in depth determination of electron microscope stereo pictures. J.-G. HELMCKE AND H. J. ORTHMANN. *Optik*, **11**, *No.* 12, 562–77 (1954) In German.

A continuation of previous work on stereo pictures [Abstr. 8337 (1954)]. The determination of depth to an accuracy of 1–2% is discussed, and it is concluded that the accuracy of setting of the convergence angle is the limiting factor. Practical details and technique are to be published later. A.E.I. RESEARCH LABORATORY

537.533.35

2786. The use of ZnS single crystals as fluorescent screens in the electron microscope. H. AREND, R. BROSER-WARMINSKY AND E. RUSKA. *Z. wiss. Mikr.*, **62**, *No.* 1, 46–64 (*Oct.*, 1954) In German.

A comparative study has been made of a number of fluorescent materials used for observing the image in an electron microscope. The primary object was to compare grainless materials (single crystals of ZnS and CdS, and uranium glass) with the powders usually employed (a ZnS/CdS mixture and a ZnO of fine grain). Observations were made at a number of voltages between 10 and 60 kV, using metal grids and diatoms as test objects. Measurement was made of the light intensity L and the resolving power δ: the quotient L/δ^2 is used as an index of relative efficiency. On this scale uranium glass is worse than the usual materials, but the single crystals are appreciably better; in fact the latter have better resolving power than the photographic emulsions normally used for recording. This is an advantage in focusing but especially in permitting a lower electron magnification and therefore lower energy loading of the specimen. The design is briefly discussed of a combined electron and optical microscope, with an electron magnification of 1000×, and an optical magnification of 10× on the primary negative; with a further photographic enlargement of 6× the overall maximum magnification would be 60 000. V. E. COSSLETT

537.533.35 : 539.27

2787. Trends in electron microscopy in the United States. R. W. G. WYCKOFF. *Z. wiss. Mikr.*, **62**, *No.* 2, 87–91 (*Dec.*, 1954) In German.

A general review, without references or illustrations, of recent developments in the techniques and applications of the electron microscope in the United States. Biological and medical uses are primarily discussed, attention being drawn to the small amount of effort being devoted to fundamental problems of electron optics and new types of electron microscopes as compared with recent progress in Europe. V. E. COSSLETT

537.533.35 : 539.165.08

2788. Beta-spectrometer permitting the study of β-γ radiations in coincidence. J. MOREAU. Letter in *J. Phys. Radium*, **15**, *No.* 11, 776–7 (*Nov.*, 1954) In French.

A realization of a spectrometer proposed by Kofoed-Hansen [Abstr. 8043 (1950)]. The introduction of magnetic "polar plaques" enables the source and detector to be situated in a region of weak magnetic field, thus eliminating interference between the β-spectrometer field and the γ-detector. G. D. SIMS

537.533.74

2789. On the velocity analysis of electrons scattered by thin foils. H. WATANABE. *J. Phys. Soc. Japan*, **9**, *No.* 6, 920–8 (*Nov.–Dec.*, 1954).

Results of measurement on the energy loss of 22 keV electrons after passing through various substances—metals, metal oxides, NaCl, $Ca(OH)_2$ and collodion—are given. The apparatus used was an electron velocity analyser of Möllenstedt type. The design and construction of the analyser is briefly described and some discussions are given on the results obtained. A.

537.533.74

2790. On source scattering in angular correlation experiments with soft electrons. E. BREITENBERGER. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 12, 1108–10 (*Dec.*, 1954).

An idealized model is described, leading to an expression for an upper limit to source-scattering errors. In terms of the model, counting methods can be devised to eliminate angular dependence of these effects. N. M. KING

537.533.74

2791. High energy electron scattering by polarized nuclei. S. FERRONI AND S. FUBINI. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 1, 263–5 (*Jan.*, 1955).

General formulae for the first-order effect of a quadrupole moment are given. A rough calculation indicates that this would cause a large azimuthal effect in the scattering. G. E. BROWN

537.533.74

2792. Electron scattering in photographic emulsions. A. HUSAIN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 1, 45–9 (*Jan.*, 1955).

Electron-electron scattering and multiple scattering are investigated for incident electrons of energies 6·6, 11·5 and 18 MeV. The results agree roughly with theory. G. E. BROWN

537.533.74

2793. Scattering of 0·6-, 1·0-, and 1·7-MeV electrons from aluminium and gold. R. T. BAYARD AND J. L. YNTEMA. *Phys. Rev.*, **97**, *No.* 2, 372–9 (*Jan.* 15, 1955).

The relative differential cross-sections have been measured over the angular range 30° to 150°. No significant deviation from the theoretically expected

angular distribution was observed. Absolute differential cross-sections were measured at 60° for aluminium at the same energies. The data are in agreement with the theoretical predictions within the experimental error. A.

537.533.74

2794. Elastic scattering of high energy electrons by mercury. G. E. BROWN AND L. R. B. ELTON. *Phil. Mag.*, **46**, 164–76 (*Feb.*, 1955).

An attempt is made to fit experimental results for the scattering of electrons by heavy nuclei at 126, 154 and 183 MeV with curves obtained from various assumed nuclear models by way of a phase-shift analysis carried out for the case of mercury. At these energies only nuclear scattering is important and the nuclear model completely determines the scattering. Charge distributions which reproduce the experimental curves either are homogeneous or have a slight dip near the centre of the nucleus and have their main decrease on the surface of the nucleus over a transition range of between $1{\cdot}7$ and $3{\cdot}2\times10^{-13}$ cm. The root mean square radius of the distribution is determined to be approximately $R = 1{\cdot}2\times10^{-13}\times A^{1/3}$ cm, to a relative accuracy of about 5%. A.

537.533.75

2795. Determination of the Boltzman[illegible]olarization correction for the slowing [illegible]onductivity coefficients of 3 to 15 MeV. G. BREITLING[illegible]OS, are R. GLOCKER. Note in *Naturwissenschaften*, **41**, *No.* 20, 471–2 (1954) In German.

The Fermi correction is investigated experimentally by sending electrons through thin sheets of fluorescent material and measuring the intensity of light (which is proportional to the energy loss). This is compared with the loss in air, where the Fermi effect will not become operative until much higher energies.

G. E. BROWN

537.533.9

2796. Asymptotic properties of Bessel functions and the radiation from a synchrotron. D. PARK. *J. Math. Phys.*, **33**, *No.* 2, 17[illegible] effect[illegible], 1954).

The behaviour [illegible]NOT. [illegible]nction $J_p(x)$ is investigated for values of x in the neighbourhood of p when p is large. The resulting formulae allow the evaluation (with an accuracy which can be estimated and in a form suitable for computation) of the power radiated in the nth harmonic by an electron moving in a circular path under the action of a magnetic field.

L. PINCHERLE

537.534

2797. A simple theoretical model for the study of the motion of ions in a linear accelerator. M.-Y. BERNARD. *J. Phys. Radium*, **15**, *No.* 10, 121 A–132 A (*Oct.*, 1954) In French.

The model leads to a particularly simple relation between the energy of the particle and its position in the accelerator. The model is used to study the longitudinal motion of the particles and their axial stability. Numerical calculations applying the model to existing accelerators show its validity. J. HUGHES

537.534 : 538.569

2798. On the radiation induced acceleration of elementary electric particles. F. OLLENDORFF. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 348–58 (*March*, 1954; publ. *June*, 1954).

Particle acceleration produced by the radiation pressure of a propagated electromagnetic wave is discussed. It is suggested that, if the particle is guided by an additional magnetic field parallel to the wave normal, the magnitude of the effect might be increased sufficiently for use in particle accelerators.

R. A. NEWING

537.534.3

2799. Corpuscular microscopy using lithium ions. M. GAUZIT. *Ann. Phys.* [*Paris*] **9**, 683–730 (*Nov.–Dec.*, 1954) In French.

The use of heavy positive ions in microscopes is discussed. An electrostatic electron microscope was modified to serve as an experimental ion type. The ion gun had a solid source, consisting of complex aluminium silicates mounted on tungsten wire. For efficient operation a vacuum of 10^{-5} mm Hg was necessary. Special viewing screens and photographic plates were also considered essential. The complex nature of the beam (ions and electrons) leads to multiple images. Using magnetic field analysis, various positive ions of the alkali metals together with some negative ions have been detected. The microscope has applications to mass spectrometry, leading to sensitive methods of isotope determination. As a microscope the resolution is about 80 Å, a limit apparently determined by the object itself. R. REED

537.534.3

2800. A peak height comparison method for mass spectrometry. C. TAYLOR. *Ark. Fys.*, **8**, *Paper* 19, 201–10 (1954).

A circuit is described which scans alternately the tops of two mass peaks whose amplitude is to be compared, and couples in a precision potential divider when the larger of the two peaks is being scanned. The divider is adjusted by hand so that the peaks, which are displayed on a potentiometric recorder, are brought to the same height, and their amplitude ratio is then read off directly from the setting of the divider. By backing off the recorder, the gain may be increased while still keeping the peaks on scale, and in this way a change in ratio of 1% may be expanded to 20 mm or more on the paper of the recorder. The device can be used for mass pairs which may be widely separated, and may lie anywhere in the range of the spectrometer. A.

537.534.3

2801. Some properties of a simple omegatron-type mass spectrometer. A. G. EDWARDS. *Brit. J. appl. Phys.*, **6**, *No.* 2, 44–8 (*Feb.*, 1955).

An experimental investigation is described, designed to show the effect of changing tube parameters on the resolution, sensitivity and resonant frequency for the N_2^+ peak recorded by an omegatron-type mass spectrometer. Various departures from simple operation are reported, some of which are attributed to space charge, but it is shown that, under suitable operating conditions, the omegatron may readily be used for analysing simple mixtures of the lighter gases. For the apparatus described, the partial pressure detection limit at low total pressures is about 10^{-11} mm of mercury. A.

537.534.6

2802. Charge equilibrium ratios for hydrogen ions from solids. J. A. PHILLIPS. *Phys. Rev.*, **97**, *No.* 2, 404–10 (*Jan.* 15, 1955).

Experimental values for the ratios of the positive, neutral and negative components have been obtained for proton beams in the energy region 3–200 keV emerging from Al, Be, Ca, Ag, Au and SiO foils. Clean surfaces were obtained by evaporating fresh material on to the foil during a run. As expected, the equilibrium charge ratio appears to be determined by the last few (~5) atoms on the exit side of the foil. At 37 ± 3 keV, the positive and neutral components are equal for all materials tested, except Ca (18 ± 2 keV). Significant differences have been found in the charged components from these metals. The observed ratios of the components for different metals parallel their work-functions at proton energies >100 keV. A.

537.534.72

2803. A panoramic mass spectroscope for kinetic studies. E. G. LEGER. *Canad. J. Phys.*, **33**, *No.* 2, 74–95 (*Feb.*, 1955).

A mass spectroscope capable of recording the trend of many chemical species in rapid gas-phase reactions is described. The instrument represents a departure from analytical mass spectrometric practice by using a molecular streaming source, rapid electric scanning, an electron multiplier ion detector amplifier, and a cathode-ray tube display. A 40-peak spectrum can be scanned in five milliseconds and recorded by a motion picture camera. A few results obtained with this instrument in the study of diethyl ether cool flames are given. A.

537.534.72 : 539.155.4 : 539.172.13

2804. On heavy particle spectroscopy technique, its application to scattering mass analysis and to the $Al^{27}(d, \alpha)Mg^{25}$ and $Al^{27}(d, p)Al^{28}$ reactions. H. A. ENGE. *Univ. Bergen Arbok.*, **1954**, *No.* 1, 101 *pp.*

Comprehensive review. A relativistic expression for the *Q*-value is derived, and the effects due to thermal motion are shown to be too small for observation here. Apparatus used with a 2 MeV Van de Graaff and a 180° focusing magnetic spectrograph is described, and the preparation of targets discussed. Limitations in resolving power, and the probable errors associated with the use of an Hρ-value as secondary standard, are analysed. Values of *p*, *d*, *t*, and α-particle energies are tabulated for a wide range of Hρ-values. A method of mass analysis of the Al target by means of the elastically-scattered deuteron energy spectrum is discussed in detail, and possible extensions envisaged. From the α-spectrum, excitation energies for 11 levels in Mg^{25} were obtained, with probable errors from 6 to 15 keV. The *p*-spectrum leads to a high level density in Al^{28}, and 49 levels up to 6·307 MeV were measured with probable errors from 3 to 8 keV. The significance of the results is discussed in comparison with the levels of neighbouring nuclei. N. M. KING

537.534.74

2805. Proton-proton scattering at 437 MeV. R. B. SUTTON, T. H. FIELDS, J. G. FOX, J. A. KANE, W. E. MOTT AND R. A. STALLWOOD. *Phys. Rev.*, **97**, *No.* 3, 783–91 (*Feb.* 1, 1955).

A detailed account of measurements, already briefly reported, of the angular distribution of proton-proton scattering at 437 MeV. A description is given of the external proton beam: its collimation, angular spread, energy spectrum and intensity. The counters, electronics, and targets are described. Two scattering arrangements were used. In one the polyethylene–carbon subtraction method with coincidence detection of the scattered and recoil protons was employed. In the other a counter telescope detected the protons emerging at a given angle from a liquid hydrogen target; at the larger angles but not at the smaller the scattered pairs could also be detected by coincidences between the telescope and another counter. At the smaller angles, when coincidence counting could not be used to insure detection of elastic *p–p* scattering, precautions were taken to absorb the particles produced in inelastic *p–p* collisions. The results are that the differential cross-section for elastic proton–proton scattering rises smoothly from its value at 90° c.m. to a value about 20% higher at 17° c.m. The value at 90° c.m. is 3·49 ± 0·17 mb/sterad. A.

537.534.74 : 539.172.13

Possible triple-scattering experiments. *See Abstr.* 3090

537.534.75

2806. Slowing down of polarized protons. E. HEIBERG, U. KRUSE, J. MARSHALL, L. MARSHALL AND F. SOLMITZ. Letter in *Phys. Rev.*, **97**, *No.* 1, 250–1 (*Jan.* 1, 1955).

Attenuation of a 425 MeV 54% polarized beam with CH_2, C, Cu, Pb shows that in the range 425–115 MeV no depolarization occurs. Polarizations produced in the degraded beam by 20° and 30° scattering on Be are consistent with the expected spreading out of the elastic diffraction pattern and the decrease of polarization below 140 MeV observed at Harwell (results to be published). W. J. SWIATECKI

DISCHARGE TUBES . COUNTERS 537.54

537.542

2807. A trap-current controlled emission regulator for a mass spectrometer ion-source. D. GREENHALGH AND P. M. JEFFERY. Letter in *J. sci. Instrum.*, **32**, *No.* 1, 36–7 (*Jan.*, 1955).

A circuit is described which is a simple modification of the Nier type emission-current regulator. It is arranged to stabilize the electron current to the "trap" of the ion source instead of the total emission. This can give more satisfactory operation of the ion source even if there are electrical leakages in the source assembly. Performance figures are given. D. R. CHICK

537.542

2808. Geiger counters, their associated circuits and counting techniques. E. PICARD AND A. BENOIT. *Onde élect.*, **34**, 652–62 (*Aug.–Sept.*, 1954) In French.

A general review paper which includes in turn (i) an elementary and introductory exposition of

mechanisms, etc.; (ii) limitations to counting; (iii) circuits; and (iv) typical applications. The latter includes counting of α-, β-, X- and γ-rays.

J. D. CRAGGS

537.542

2809. The behaviour of Geiger-Müller counters with an external graphite cathode at high counting rates. D. BLANC. Letter in *J. Phys. Radium*, **15**, *No.* 10, 693–4 (*Oct.*, 1954) In French.

The influence of high counting rates on the length and slope of the plateau and the threshold were investigated. The counter used had an internal cathode and a resistance condenser network was used to simulate the effect of the glass wall. J. HUGHES

537.542

2810. On the distribution of delays in Geiger-Müller counters. E. PICARD AND A. ROGOZINSKI. *J. Phys. Radium*, **15**, *No.* 11, 767–75 (*Nov.*, 1954) In French.

An oscillographic method was used to determine the delay between a particle passing through a fixed region of the counter and a pulse being delivered from its associated amplifier. A cosmic-ray telescope was used to define the position of the particle with respect to the counter wire. The delays were studied as functions of the distance of the particle path from the central wire d, and the overvoltage V_s applied to the counter. It was found that the statistical distribution of delays was greater, for large values of d and small values of V_s. J. HUGHES

537.542

2811. Study of the coefficient of ionic multiplication in counters filled with CO_2. R. FOURAGE AND L. MIRAMOND. Letter in *J. Phys. Radium*, **15**, *No.* 11, 780–1 (*Nov.*, 1954) In French.

This was measured for counter fillings of pure CO_2 and CO_2–alcohol mixtures from 1 to 76 cm pressure and the results are presented graphically. The experimental values are compared with the theoretical predictions of Rose and Korff. J. HUGHES

537.542

2812. The influence of the region of limited proportionality on thresholds of Geiger counters with glass tubes and external graphite cathodes. D. BLANC. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1621–2 (*Dec.* 8, 1954) In French.

A brief note on pulse-size/voltage relations for external cathode counters. A simple theoretical treatment is given, with semi-qualitative experimental verification. J. D. CRAGGS

537.542

2813. Geometric efficiency of cylindrical counters. J. GOLDEMBERG. *Rev. sci. Instrum.*, **26**, *No.* 1, 41–4 (*Jan.*, 1955).

Counting experiments were made with cylindrical counters fitted with geometry "definers" in order to ascertain whether it is possible to find an area of constant sensitivity in these counters. These measurements are similar to those made by Gleason *et al.* with end-window counters. It is possible to achieve this result by means of a careful choice of the dimensions of these definers. The definers also allow a great simplification of the calculation of counter efficiency for a point source. A formula is given for sources placed in any position with respect to the counter. This formula is compared with experiment and the agreement is found to be good. A comparison of absolute β-counting between one cylindrical counter (with definer) and an end-window counter (with definer) is made. The agreement obtained is satisfactory. A.

537.542 : 537.523.3

2814. Breakdown processes in nitrogen, oxygen, and mixtures. E. L. HUBER. *Phys. Rev.*, **97**, *No.* 2, 267–74 (*Jan.* 15, 1955).

The studies of corona mechanisms in coaxial cylindrical geometry with central anode using α-particle triggering, initiated by Colli and Facchini and by Lauer in inert gases, have been extended to pure nitrogen, pure oxygen, and mixtures of these gases. Pure gases were studied in a well outgassed system with nickel cathode. In pure nitrogen, from 25 to 600 mm pressure, the predominant mechanism is secondary liberation of electrons from the cathode by positive ion impact, with γ_i varying between $1{\cdot}4\times10^{-3}$ and $0{\cdot}6\times10^{-3}$. Correction for back diffusion following Theobald gives a true γ_i of $2\text{–}3\times10^{-2}$. The ion is the N_4^+ observed by Varney, with reduced mobility $2{\cdot}53 \pm 0{\cdot}08$ cm^2/volt sec at 760 mm and 20°c. Addition of the order of 1% oxygen reduces γ_i by a factor of $\frac{1}{2}$ and gives a weak photoelectric γ_p at the cathode, both effects resulting in part from action of oxygen on the cathode as noted by Parker and Theobald. Photoionization in the gas also appears, and with 5% oxygen the self-sustaining corona consists to a large extent of Geiger counter-like pulses propagating along the wire. In air, there is no longer any observable cathode action at threshold. With the use of transverse and longitudinal α-particle trajectories relative to the axis, the velocity of propagation of the discharge down the wire has been measured for various pressures in air, and for constant pressure and potential as a function of oxygen concentration of between 5 and 20%. Velocities ranged between 10^8 and 10^7 cm/sec, decreasing as oxygen concentration increased. In pure oxygen above 200 mm pressure, the absorption of photoionizing radition is so intense that, as indicated by Miller and Loeb, instead of spreading along the wire, the discharge propagates outward in the form of radial streamers, which have a duration of less than 10^{-7} sec, contain some 10^8 ions, and are spaced at regular intervals closely related to the positive-ion transit time. The latter yields a reduced mobility of $2{\cdot}2 \pm 0{\cdot}1$ cm^2/volt sec at 760 mm Hg and 20°c, in conformity with Varney's assumed O_2^+ ion. A.

537.542

2815. Corona threshold and the range of velocities of pulse spread in Geiger counters. L. B. LOEB. *Phys. Rev.*, **97**, *No.* 2, 275–7 (*Jan.* 15, 1955).

By using the writer's expression for a self-sustaining burst pulse corona and Alder, Baldinger, Huber, and Metzger's expression for the propagation of a Geiger pulse along the anode wire in coaxial cylindrical counter geometry, the limits of the velocity of spread of counter pulses can clearly be delineated. The interpretations resulting clarify the significance of the previously assumed fictive average distance of spread.

These relations are illustrated in terms of the observations on O_2–N_2 mixtures (preceding abstract). A.

537.542 : 621.387.42.089.6

2816. The stability of the calibration of liquid sample Geiger-Müller counter tubes. N. VEALL, A. E. LOWE AND R. E. WHYARD. *J. sci. Instrum.*, **32**, *No.* 2, 65–6 (*Feb.*, 1955).

It is possible to construct equipment for the automatic counting of radioactive samples in solution by placing each sample in a different counter tube of the liquid sample type (CV2145) and switching to each tube in turn. The day-to-day variation of the calibration factor of such tubes, which is the main source of error in the method, is found to be $\pm 0{\cdot}6\%$. Background errors due to γ-radiation from samples in adjacent tubes are reduced to $< 0{\cdot}1\%$ by suitable lead shielding. The results are also relevant to the use of liquid sample counters as calibrated secondary standards for the absolute assay of radioactive isotopes. A.

537.542 : 539.172.4

2817. A low-pressure ionization chamber for measurement of neutron distribution within a pile. I. PELCHOWITCH AND J. WEILL. *J. Phys. Radium*, **15**, *No.* 10, 119 A–120 A (*Oct.*, 1954) In French.

The ionization chamber, described from a diagram, has an Al case and a deposited anode of 2 mg/cm^2 B_4C. Filling gas is O or He at 4 mm Hg pressure. Curves for saturation, and calibration with neutrons are shown. Direct measurement of thermal neutrons to a flux of 10^{13}/sec.cm^{-2} is possible, and rapid response enables flux distribution within a pile to be measured.

D. V. MABBS

537.542

2818. Directional scintillation counters of improved sensitivity. E. S. WILLIAMS. *Brit. J. Radiol.*, **27**, 688–91 (*Dec.*, 1954).

Directional counters and the methods of increasing their efficiency are briefly reviewed. A simple Perspex conical crystal holder is described. This acts as a reflector, provides an airtight mounting for hygroscopic crystals, and allows a narrow aperture detector to utilize the full photocathode surface. Calcium tungstate and thallium-activated sodium iodide crystals are compared when used with such a holder. The detection efficiency of the apparatus as a whole was increased in both cases. A.

537.542

2819. Fast detector for fission counting. G. P. BOICOURT AND J. E. BROLLEY. Letter in *Rev. sci. Instrum.*, **25**, *No.* 12, 1218–19 (*Dec.*, 1954).

Scintillations from fission fragments or α-particles produced in krypton gas are converted by a plastic phosphor and detected by a photomultiplier. Pulse rise times are $< 10^{-8}$ sec and pulse widths $2–3 \times 10^{-8}$ sec at half maximum. G. F. J. GARLICK

537.542

2820. "Cosmic ray" effect in photomultiplier tubes. E. M. BAKER AND B. M. TOLBERT. Letter in *Rev. sci. Instrum.*, **25**, *No.* 12, 1218 (*Dec.*, 1954).

Using two photomultipliers in coincidence "seeing" each other through a scintillator an extra background count occurs which is traced to light pulses from cosmic rays passing through one or other of the tubes. Lead shielding minimizes the effect.

G. F. J. GARLICK

537.542

2821. Resolution losses in counters and trigger circuits. P. E. DAMON AND P. N. WINTERS. *Nucleonics*, **12**, *No.* 12, 36–9 (*Dec.*, 1954).

Resolution losses, in circuits in which no re-excitation is possible during recovery, following the recording of a pulse from a random sequence, are discussed. Results of experiments with a univibrator having this characteristic, with resolution time independent of counting rate and a Geiger counter, in the region of high losses, are described. L. R. SHEPHERD

537.542 : 621.374.32

2822. An arrangement for the reduction of the time of resolution of electronic scalers of impulses. R. FAVRE. *Helv. phys. Acta*, **27**, *No.* 7, 683–9 (1954) In French.

Describes circuits based on a blocked multivibrator as the first stage of the scaler. Error curves are calculated and applications suggested. J. DUTTON

537.542

2823. Improvement in rubber diaphragm cloud-chamber technique. H. BLUMENFELD, E. T. BOOTH AND L. M. LEDERMAN. Letter in *Rev. sci. Instrum.*, **25**, *No.* 12, 1220 (*Dec.*, 1954).

In rubber diaphragm chambers which incorporate a velvet baffle mounted on a perforated plate, it is found to be advantageous to insert a clearing field electrode between the velvet grid and the rubber diaphragm. P. ROTHWELL

537.542

2824. Characteristics of bubble chambers. D. A. GLASER AND D. C. RAHM. *Phys. Rev.*, **97**, *No.* 2, 474–9 (*Jan.* 15, 1955).

The bubble chamber is a new radiation detector in which ionizing events produce tracks consisting of strings of tiny bubbles in a superheated liquid. By means of fast flash photography, practically distortionless bubble tracks can be recorded for the study of high-energy nuclear events. A chamber six inches long has been constructed and chambers several feet long seem feasible, so the bubble chamber can have both high stopping power and large size. Liquids containing only elements of low atomic number can be used to minimize Coulomb scattering so that accurate magnetic curvature measurements can be made. Tracks of minimum ionizing particles contain up to 100 bubbles per centimetre, and the bubble density varies with ionization density, thus making bubble counting a possible method for measuring ionization. The short sensitive and resetting times of bubble chambers tend to reduce background radiation problems and increase data collection rates for experiments with pulsed accelerators. Unfortunately the lifetime of the bubble nuclei seems to be too short to permit counter-controlled expansion after the passage of the particle to produce tracks. Therefore it is unlikely that the types of bubble chambers described here will be useful for cosmic-ray experiments. A.

IONIZATION . THERMIONICS 537.56/.58

537.561

2825. Appearance potential studies. II. Nitromethane. R. J. KANDEL. *J. chem. Phys.*, **23**, *No.* 1, 84–8 (*Jan.*, 1955).

For Pt I, see Abstr. 11163 (1954). Appearance potentials and excess kinetic energies have been determined for the ions produced by the ionization and dissociation of nitromethane by electron impact in a mass spectrometer. Bond dissociation energies and mechanisms of fragmentation have been deduced where possible. $D(CH_3 - NO_2)$ has been found to be 2·56 V, a value in agreement with thermochemical data. The dissociation and ionization process yielding NO^+, the most abundant ion in the nitromethane mass spectrum, is believed to yield, at the same time, a CH_3O radical. A new value for the ionization potential of NO_2, 9·91 V, is reported. A.

537.562

2826. Ionization and fragmentation of N_2 by bombardment with atomic ions. Dissociation energy of N_2. E. LINDHOLM. *Ark. Fys.*, **8**, *Paper* 26, 257–63 (1954).

The charge exchange in collisions between atomic ions and nitrogen molecules has been investigated. The fragments N_2^+ and N^+ from the molecule have been analysed in a second mass spectrometer. The measurements confirm the earlier result that when the recombination energies of the ion are appreciably lower than the appearance potentials of the molecule, the cross-section for the charge exchange is small. In the collisions of He^+ the cross-section for formation of N^+ is large, which explains the high intensity of the N_2^+ bands in the spectrum from a discharge through a mixture of He and N_2. In the collisions of Ne^+ the cross-section for formation of N^+ is large, too. As the recombination energy for Ne^+ is 21·6 eV, this shows that the N_2^+ molecular ion may dissociate when it has absorbed about 6 eV, and this means that the values for the dissociation energies 6·338 eV for N_2^+ and 7·373 eV for N_2, given by Herzberg and Hagstrum, seem to be proved. The desirability of further spectroscopic investigations using a discharge through a mixture of Ne and N_2 is pointed out. A.

537.562

2827. Formation of negative ions in hydrocarbon gases. T. L. BAILEY, J. M. MCGUIRE AND E. E. MUSCHLITZ, JR. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2088–9 (*Dec.*, 1954).

Gives results of a mass spectrometer study of negative ions produced by electron bombardment of methane, ethane and acetylene gases. The relative intensities of the ions (masses 1, 25 and 12–15) observed and a mass spectrum for methane are given. J. DUTTON

537.562 : 537.525.8

2828. Decomposition of methane in low-pressure glow discharge. M. BURTON AND J. P. MANION. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2095 (*Dec.*, 1954).

Describes experiments in a Penning-type glow discharge, at $\sim 10^{-4}$ mm Hg pressure, from which the fractions of molecules ionized or decomposed could be deduced. The results are briefly discussed.

J. D. CRAGGS

537.564

2829. Inelastic collisions between heavy particles. IV. Contribution of double transitions to certain cross sections including that associated with the ionization of hydrogen atoms in fast encounters with other hydrogen atoms. D. R. BATES AND G. W. GRIFFING. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 90–6 (*Feb.*, 1955).

For Pt III, see Abstr. 2090 (1955). Born's approximation is used to calculate the cross-sections associated with the processes $H(1s) + H(1s) \rightarrow H(3s, p \text{ or } d) + H(3s, p \text{ or } d)$ and $H(1s) + H(1s) \rightarrow H^+ + e + H(3s, p \text{ or } d;$ or C) where C represents the continuum. These cross-sections and others calculated in Pt I and II are combined to yield the cross-section for excitation to the third quantum level, the cross-sections for ionization and the total cross-section for all inelastic collisions. Both single and double transitions are taken in account. The ratio of the electron loss cross-section to the electron capture cross-section is computed. A.

537.564 : 534.222.2

2830. Electrical conductivity of highly ionized argon produced by shock waves. S.-C. LIN, E. L. RESLER AND A. KANTROWITZ. *J. appl. Phys.*, **26**, *No.* 1, 95–109 (*Jan.*, 1955).

Shock tube techniques for the production of shock waves up to Mach number 20 have been developed and reported previously [see Abstr. 681 (1953)]. These techniques can produce high temperature gas with accurately known enthalpy (e.g. in argon 25% ionization has been produced following an incident shock). Spectroscopic studies of high temperature argon produced this way [see Abstr. 2569 (1955)] showed that equilibrium ionization can be reached in the time available in these experiments (of the order of 100 μsec). This paper reports a study of the electrical conductivity of high temperature argon produced by shock waves. At low degrees of ionization (less than 10^{-3} for argon), the diffusivity of electrons and thus the gas conductivity is determined by the cross-section for electron-atom collisions which has been measured by mobility and by scattering techniques. At high degrees of ionization (larger than 10^{-3} for argon) the diffusion of electrons is primarily limited by long-range Coulomb interaction with positive ions and thus is independent of the chemical nature of the gas. Theoretical treatments of this case have been given by Chapman and Cowling, Cowling, and by Spitzer and Härm. At intermediate degrees of ionization additive effects of both of these resistivity mechanisms would be expected. Preliminary measurements with electrodes indicated large surface resistances. These effects were avoided by the development of an electrodeless technique in which the moving ionized gas deflected a magnetic field. Resultant voltages induced in a search coil were related to the conductivity distribution in the gas following the shock wave. At temperatures greater than 8000–10 000°K (depending on the gas density) the gas conductivity quickly reached a maximum value (up to 80 mhos/cm). The maximum conductivity

obtained at these high temperatures agreed within 10% with theoretical expectations. It also agreed well with measurement of electrical resistivity in the caesium discharge by F. L. Mohler [*Bur. Standards J. Research*, **21**, 873 (1938)]. At lower temperatures the oscillograms indicated that the conductivity was still rising at the end of the hot region. Under these conditions maximum conductivities reached were much lower than the theoretical values. The ionization rate obtained varied considerably with the gas density. At the highest temperatures the conductivity declined quickly from the maximum value and the rate of decline could be correlated with the expected cooling due to recombination radiation. Indications of a high conductivity associated with luminous shock fronts were obtained. A.

537.568

2831. Further investigations of charge exchange and electron detachment. I. Ion energies 3 to 40 keV. J. B. H. Stedeford. **II. Ion energies 100 to 4000 eV.** J. B. Hasted. *Proc. Roy. Soc. A*, **227**, 446–76, 476–85 (*Feb.* 8, 1955).

See Abstr. 5482 (1949); 4434 (1952). This paper describes the measurement of charge transfer cross-sections for protons, molecular hydrogen ions and helium ions in the rare gases and hydrogen, and electron detachment cross-sections for negative atomic hydrogen ions in the rare gases. Pt I describes the energy range 3 to 40 keV. In Pt II the energy range 100 to 4000 eV is described, and the results are discussed in terms of the pseudo-adiabatic hypothesis. Comparisons are made with other experimental results, and anomalous molecular cases are discussed in terms of reactions involving anti-bonding states. A.

537.581

2832. Patch effect for the thermionic emission from polycrystalline tantalum. W. B. LaBerge, R. J. Munick, J. A. Dezoteux, J. F. Whalen and E. A. Coomes. *J. appl. Phys.*, **26**, *No.* 2, 241–3 (*Feb.*, 1955).

The slope modifications for the Schottky line implied by simple patch theory have been obtained at high fields for thermally etched tantalum filaments. For a.c.-aged filaments, only the usual low field patch modification was obtained. For d.c.-aged filaments an additional anomaly at higher fields was obtained, simultaneous with the appearance of the d.c. etch pattern on certain faces of the crystal grains. This high field anomaly consisted of a double break in slope, and appeared at an average patch field about 50 times the patch field due to the distribution of crystal faces. A.

537.583 : 621.385.032.216

2833. Growth of the barium orthosilicate interface of oxide-coated cathodes. M. G. Harwood and N. Fry. *Brit. J. appl. Phys.*, **6**, *No.* 2, 62–4 (*Feb.*, 1955).

The core-coating interface of oxide cathodes with Ni alloy cores containing 0·048 and 0·17% Si has been examined. In addition to Ba orthosilicate a layer of nearly pure SrO was found. The growth of the Ba orthosilicate layer with time of heating the cathodes was examined. In the case of the first alloy, growth continued until all the available Si was used, but this was not so for the alloy of higher Si content, where other factors, possibly diffusion of Si through Ba orthosilicate, appeared to limit the growth. A.

537.585

2834. Effects of smokes on atmospheric ionization. R. A. Hessemer, Jr. *J. Franklin Inst.*, **258**, *No.* 1, 31–42 (*July*, 1954).

An experimental study of the effect of tobacco and bath wax smokes on the emission of ions from hot filaments (of types used in electric heater and ion sources) under atmospheric conditions. J. DUTTON

537.585

2835. On the ion emission of glass. B. Lengyel and F. Till. *Z. phys. Chem.* [*Leipzig*] **203**, *No.* 5–6, 312–17 (*Oct.*, 1954) In German.

Apparatus used to measure ion emission from glass at 470°c under a vacuum of 10^{-6} mm Hg is described. The emission from soda glass was $\sim 3{\cdot}5 \times 10^{-9}$ A/cm^2 under a voltage of 200 V. The dependence of emission upon glass composition was determined using five specimens of varying Na : K content, from "pure" Na to "pure" K. A marked minimum in the emission–composition curve was observed when the Na to K ratio was unity. This minimum is compared with a similarly placed minimum obtained from extrapolated data on conductivity measurements. It is considered that the agreement indicates that the reduction in conductivity prevents ion diffusion to the surface and so reduces ion emission. C. G. MORGAN

537.585

2836. Contribution to the study of solid ion sources. Application to secondary electron emission and to ion microscopy by emission. G. Couchet. *Ann. Phys.* [*Paris*] **9**, 731–81 (*Nov.–Dec.*, 1954) In French.

The preparation of solid ion sources based on alkali metal–aluminium silicates is discussed. The emission of such materials mounted on tungsten filaments is appreciable and follows Richardson's law. The construction of a successful ion gun is fully described and the distribution of secondary electrons under the impact of Li^+ is investigated for a number of materials. The use of such a gun in ion microscopes is dealt with, together with technical points concerning specimen preparation, suitable viewing screens and photographic emulsions. Ionic emission depends on the crystallographic orientation of the surface and the ions and the electrons appear to issue from different points. The isotopes emitted from solid sources were analysed by mass-spectrometric methods. At low temperatures, the emission of impurities may exceed that of the principal ion.

R. REED

537.585

2837. A mass spectrometric study of gaseous species in the Al–Al_2O_3 system. R. F. Porter, P. Schissel and M. G. Inghram. *J. chem. Phys.*, **23**, *No.* 2, 339–42 (*Feb.*, 1955).

The vaporizing species in the Al–Al_2O_3 system are identified mass spectrometrically. Intense ion currents of Al_2O^+ formed from gaseous Al_2O are observed. At $T = 1750°K$ ions formed from other gaseous oxides are at least 1000 times less intense than Al_2O^+. The appearance potential of Al_2O^+ is

$7{\cdot}7 \pm 0{\cdot}2$ eV. A thermodynamic treatment of gaseous Al_2O gives for $Al_2O(g) = 2Al(g) + O(g)$, $\Delta H_{298} = 256 \pm 7$ kcal. A.

COSMIC RAYS 537.591

537.591 : 523.165

Origin of cosmic radiation. *See Abstr.* 2366

537.591.1

2838. Hodoscope study of cosmic radiation. M. Biasutti, R. Favre, C. Haenny and A. Heym. *Helv. phys. Acta*, **27**, *No.* 6, 484–5 (1954) In French.

Gives a brief account of a large counter hodoscope system for use in cosmic-ray studies. Reliability of operation has been tested and found satisfactory by using it to measure the absorption length in lead of the neutral penetrating component of the cosmic radiation. H. ELLIOT

537.591.1 : 539.18

2839. A determination of μ-mesotron rest lifetime and a verification of the relativistic expression for variation of lifetime with momentum. D. W. Seymour and W. F. G. Swann. *J. Franklin Inst.*, **258**, *No.* 4, 277–86 (*Oct.*, 1954).

Measurements of cosmic-ray intensity have been made simultaneously with counter telescopes at altitudes differing by about 3000 ft and in locations which were the same within a distance of about 8 miles. Data were obtained for various thicknesses of lead absorber and with an additional thickness of absorbing material in the upper telescopes to compensate for absorption in the air column between the two sets of telescopes. From this data the rest mean life values have been calculated on the basis of the relativistic variation of mean life with momentum for various ranges of momenta of the rays concerned. The theory of the calculation allows for the continual change of mean life resulting from loss of momentum of the mesons as they pass through the air. The value of the rest mean life obtained is $2{\cdot}3 \times 10^{-6}$ sec and is constant over the ranges of momenta concerned, within the limits of accuracy of the data, thus confirming to this extent the relativistic expression. The results are in close agreement with those of Rossi *et al.*, but differ from the results obtained by Nielsen. A.

537.591.15

2840. A study of shower curves with the multiplate cloud chamber. K. Hinotani, K. Suga and Y. Tanaka. *J. Phys. Soc. Japan*, **9**, *No.* 6, 883–7 (*Nov.–Dec.*, 1954).

With the multiplate cloud-chamber, cosmic-ray cascade showers up to 800 MeV were examined with respect to the shower curves and fluctuation. The form of the shower curve is in good agreement with the Wilson Monte Carlo curve. And the fluctuation in the number of shower particles seems to be of the Poisson type. From the Shapiro experiment and the author's, Wilson's results seem to be most reliable in both the absolute value and the form of the shower curve at least up to 800 MeV. A.

537.591.15

2841. On narrow showers of pairs of charged particles. A. Debenedetti, C. M. Garelli, L. Tallone, M. Vigone and G. Wataghin. Letter in *Nuovo Cimento*, **12**, *No.* 6, 954–6 (*Dec.*, 1954).

Gives a preliminary account of measurements on two showers observed in stripped emulsions. The showers consist only of pairs of charged particles (presumably electrons) and are similar to the event described by Schein *et al.* [Abstr. 10304 (1954)]. H. ELLIOT

537.591.15

2842. The transition curve of the photon component of extensive air showers. J. M. Massalski. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 7, 335–40 (1954).

537.591.2

2843. On the spectrum of the photon component in the lower atmosphere. C. Cernigoi and G. Poiani. Letter in *Nuovo Cimento*, **12**, *No.* 6, 957–8 (*Dec.*, 1954) In Italian.

The absorption of the photon component in lead, at sea level and at mountain altitude has been measured with an anticoincidence counter telescope. The absorption coefficient is slightly higher at mountain altitude than at sea level, as is to be expected if appreciable numbers of photons at mountain altitude are produced by π^0s. P. ROTHWELL

537.591.3

2844. On the influence of low energy (2–7 MeV) photons on the absorption curve of extensive air showers in lead. J. Jurkiewicz. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 7, 329–34 (1954).

The absorption curve for air showers has been obtained using three trays of counters separated by 3·4 m and placed in coincidence with a two-fold counter telescope. This telescope could be shielded by selected thicknesses of lead absorber. Maximum contribution to the counting rate by low-energy photons is found to occur under 8 cm lead. H. ELLIOT

537.591.3

2845. On the absorption of cosmic rays underground. S. Higashi, M. Oda, T. Oshio, H. Shibata and K. Watanabe. *J. Phys. Soc. Japan*, **9**, *No.* 5, 655–8 (*Sept.–Oct.*, 1954).

Local absorption in lead absorbers in a counter telescope has been measured at depths of 20, 25·5 and 40 m.w.e., and compared with the absorption produced by increasing the depth underground. It was found that the former agrees with the latter within the limit of accuracy of the measurement. The results show that at least 98% of cosmic rays underground consist of mu-mesons coming from the atmosphere, and that the remainder have short ranges and may be composed of electrons produced by mu-mesons in the ground. Cosmic rays underground created by unknown processes are probably very few. A.

537.591.3

2846. On the energy loss, by ionization, of the nucleonic component in the atmosphere. Tsai-Chü and M. Morand. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 25, 1786–8 (*Dec.* 20, 1954) In French.

This has been calculated for three different latitudes using the observed momentum spectrum. The value

for latitude 50° is 120 MeV.cm^{-2}.sec^{-1}.sterad^{-1}, which is twice as big as that deduced by Rossi [Abstr. 1964 (1949)]. H. ELLIOT

537.591.5

2847. Influence of the geomagnetic field on the extensive air showers. P. CHALOUPKA. Letter in *Phys. Rev.*, **96,** *No.* 6, 1709 (*Dec.* 15, 1954).

Measurements have been made at an altitude of 2634 m at 48°N geomagnetic latitude in order to study the influence of the earth's magnetic field on the lateral spread of air showers. Two counter telescopes in coincidence separated by 7 m were used and these were successively orientated towards north, south, east and west at zenith angle 45°. The observed frequencies indicate that the spread of the showers is affected by the earth's field. H. ELLIOT

537.591.5

2848. Variations of the cosmic ray intensity during magnetic storms. E.-Å. BRUNBERG AND A. DATTNER. *Tellus*, **6,** *No.* 3, 254–9 (*Aug.*, 1954).

A simple mechanism has been suggested by Alfvén [Abstr. 4853 (1949)] to explain the main features of the variation of cosmic-ray intensity during magnetic storms. Cosmic-ray particles are accelerated or retarded in the electric fields of ionized beams, which are sent out from the sun. Particle orbits hitting the earth have been calculated for different momenta and for solar magnetic fields decreasing with distance as r^{-3}, r^{-2} and r^{-1}. The influence on the particles of beams of different length and breadth has been analysed. A beam length of a few times the orbital radius of the earth and particles with momenta in the range 20–40 GeV Z/c give a time variation in cosmic-ray intensity similar to the variation measured during a magnetic storm. This requires a solar magnetic field of 10^{-5} gauss at the earth's orbit. A.

537.591.8

2849. On the unstable heavy meson decaying in flight in the photographic emulsion exposed at high altitudes. K. NIU. *J. Phys. Soc. Japan*, **9,** *No.* 5, 659–65 (*Sept.–Oct.*, 1954).

One unstable heavy-meson decay event was found in a photographic plate exposed at high altitude. The unstable heavy meson decayed in flight into a single lighter charged meson and was assumed to be a κ-particle on account of the energy momentum relation at the decay point. The possibility that this event occurred due to a spurious distortion such as "wetting effect" is not completely neglected, because the direction of motion of the emitted particle is very close to that of the parent. But it seems quite difficult to interpret the whole event by the wetting effect. A.

537.591.8

2850. Interaction of electrons with matter. C. A. D'ANDLAU. *Nuovo Cimento*, **12,** *No.* 6, 859–68 (*Dec.*, 1954) In French.

A cloud chamber with a single lead plate, placed in a magnetic field, has been used to study the interactions of electrons with matter at sea level. The energy of the incident electron, and the number and energy of electrons in the shower can be measured with this apparatus. The experimental results are compared with the results of shower theory, and with the results obtained by the Monte Carlo method. P. ROTHWELL

537.591.8

2851. Interactions of the heavy nuclei of the cosmic radiation. J. H. NOON AND M. F. KAPLON. *Phys. Rev.*, **97,** *No.* 3, 769–79 (*Feb.* 1, 1955).

Fragmentation probabilities have been obtained for the interactions of heavy nuclei with target nuclei of photographic emulsion and a light element absorber (gelatin and cellulose acetate). The predictions of a simple geometrical model for the fragmentation probabilities in light elements derived from those observed in emulsion are in agreement with experimental observations. Measurements of the interaction mean free paths of heavy nuclei at different latitudes indicate that the interaction cross-section is energy-insensitive and is smaller than geometric. Curves are presented showing the ratio of the secondary light element (Li, Be, B) flux relative to the medium element ($6 \leqslant Z \leqslant 10$) flux as a function of atmospheric depth. A.

537.591.8

2852. Electron tridents between 0·1 and 10 BeV. M. M. BLOCK, D. T. KING AND W. W. WADA. *Phys. Rev.*, **96,** *No.* 6, 1627–34 (*Dec.* 15, 1954).

Data on the direct production of pairs by fast electrons of the cosmic radiation have been collected in nuclear emulsions by a track-following method. Multiple-scattering measurements were made on the secondaries of 61 tridents with energies between 0·1 and 10 BeV; of these, 14 originated on arms of pairs. A mean free path of 134 ± 42 cm was deduced for the latter, corresponding to a cross-section of $0{\cdot}92 \pm 0{\cdot}29 \times 10^{-25}$ cm^2. An appropriate statistical treatment for small numbers has been adopted, and a correction has been made for the inclusion of pseudo-tridents. The theoretical cross-sections of Bhabha and Racah, which apparently disagree by a factor of about 2 in this energy region, have been shown to be consistent. The theoretical cross-section averaged over the experimental energy distribution is $0{\cdot}82 \times 10^{-25}$ cm^2. The distributions in fractional energy transfer to the created pair and internal energy partition in the pair have been derived and are compared with the authors' observations. It is concluded that trident theory is in agreement with this experiment. A.

MAGNETISM 538

538.082/.083 : 538.122

2853. The visual manifestation of magnetic fields. M. v. ARDENNE. Note in *Naturwissenschaften*, **41,** *No.* 21, 494 (1954) In German.

Claims priority [1947, publication delayed till 1953; see Abstr. 379 (1955)] for the gas discharge method ascribed by König [Abstr. 378 (1955)] to Blaha and Schedling [Abstr. 2825 (1951)]. E. P. WOHLFARTH

538.082 : 539.152.1

2854. A precision gaussmeter using nuclear resonance. D. DAUTREPPE AND J. PAULEVÉ. *J. Phys. Radium*, **15,** *No.* 12, 78 S–79 S (*Dec.*, 1954) In French.

Using the frequency of nuclear resonance to measure the magnetic field strength a precision of 5×10^{-4} is obtained in the range 800 to 6000 gauss. D. H. WHIFFEN

538.082.74

2855. Apparatus for measuring the Hall constant and the magnetic resistance change using alternating currents. K. A. MÜLLER AND J. WIELAND. *Helv. phys. Acta*, **27**, *No.* 7, 690–6 (1954) In German.

A null method is described. The potential drop between two probes attached to the specimen is balanced by a known potential of the same frequency (here 73 c/s) and opposite phase. The lowest voltage measurable is 2×10^{-8} V. The method has been used for measurements on specimens with resistances in the range 10^{-5} to 10^{2} Ω. E. P. WOHLFARTH

538.082.74

2856. An induction method for the study of field distribution along the axis of a powerful magnetic lens. P. GAUTIER. *J. Phys. Radium*, **15**, *No.* 10, 684–91 (*Oct.*, 1954) In French.

A treatment of axial field distribution in magnetic lenses is given which enables the magnetic induction B_z and its derivatives to be measured in a novel way. A small search coil mounted on a straight bar is immersed in the lens field at a particular point on the axis, the bar vibrating with small amplitude at a definite frequency (1000 c/s). The a.c. voltage developed across the ends of the coil is a function of B_z, hence field determination is reduced to a measurement of this voltage. By special arrangements of the small coils on the vibrating bar, B_z' and B_z'' can also be obtained from the voltage developed. The method has great sensitivity and full practical details of the arrangement are given. R. REED

538.113 : 539.132

2857. Non-empirical calculation of the diamagnetic anisotropy of benzene. T. ITOH, K. OHNO AND H. YOSHIZUMI. *J. Phys. Soc. Japan*, **10**, *No.* 2, 103–7 (*Feb.*, 1955).

The large anisotropy of the diamagnetic susceptibility of benzene, which is considered to be due to the free migration of π-electrons, is calculated by the antisymmetrized LCAO-MO method. All the configurations obtained by excitation of one or two electrons from the lowest configuration are included and all the many-centre integrals retained. The calculated value of the diamagnetic anisotropy is about 50% of the experimental value. The effect of configuration interaction is not small enough to be neglected. A.

538.114

2858. Application of the spherical model to antiferromagnetism. I. N. URYÛ. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, *No.* 4, 131–9 (*March*, 1954).

The method developed by Berlin and Kac [Abstr. 6615 (1952)] is applied to the antiferromagnetism of a s.c. lattice divided into 2 sublattices. Relations are derived for the susceptibility above and below the Néel point, and the critical field strength required to destroy antiferromagnetic behaviour. The ratio θ/T_c of the Curie to the Néel temperature is found to equal 1·28. E. P. WOHLFARTH

538.114

2859. Application of the spherical model to antiferromagnetism. II. N. URYÛ. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, *No.* 4, 139–45 (*March*, 1954).

The spherical model is applied to a f.c.c. lattice and high temperature series expansions (in J/kT) are obtained for the internal energy and entropy. The model does not predict antiferromagnetism for this lattice structure. E. P. WOHLFARTH

538.114

2860. On the approximate nature of the spherical model. N. URYÛ. *Mem. Fac. Sci. Kyusyu Univ. B*, **1**, *No.* 4, 146–9 (*March*, 1954).

See preceding abstract. The spherical and Ising model are contrasted in their applicability to ferromagnetic lattices. It is found that the partition functions for the two models have quite a different temperature dependence below the Curie point, but that there is more agreement between them above, the agreement being the closer the larger the co-ordination number. E. P. WOHLFARTH

538.114

2861. The $T^{3/2}$ law for the approach to saturation of ferromagnetic substances. L. NÉEL. *J. Phys. Radium*, **15**, *No.* 12, 74 S–75 S (*Dec.*, 1954) In French.

Following Schafroth [Abstr. 2562 (1954)] the relative magnetization ζ is expressed in the form $1-\zeta=\sum_{n=6}^{\infty}(-1)^n A_n(T/\theta)^{n/4}$, where the coefficients A_n are functions of the spin quantum number S and θ is the paramagnetic Curie temperature. The formula is applied to gadolinium, and conclusions are drawn as to its temperature range of validity. The often used method of estimating values of the exchange integral from low-temperature magnetization data using the $T^{3/2}$ law is criticized [see also Abstr. 4206 (1950)].

E. P. WOHLFARTH

538.114

2862. The Permalloy problem. L. NÉEL. *J. Phys. Radium*, **15**, *No.* 12, 92 S–93 S (*Dec.*, 1954) In French.

Interprets the ordering properties of $FeNi_3$ in terms of a theory of directional ordering previously described in detail [Abstr. 7548 (1954)].

E. P. WOHLFARTH

538.114

2863. Molecular field in the spherical model. M. LAX. *Phys. Rev.*, **97**, *No.* 3, 629–40 (*Feb.* 1, 1955).

The Heisenberg model of ferromagnetism is replaced by a classical model in which the interaction between a pair of neighbouring atoms is $-2JS(S+1)\epsilon_i.\epsilon_j$, where S is the spin of any atom, J is the exchange integral, and the ϵ_i are classical unit vectors. The spherical model is then used to evaluate the molecular field acting on any atom i. This effective field is found to have the generalized Weiss form, $H+W(T)M+W'(T)M'y_i^{\pi}$, where H is the magnetic field, M the magnetization, and M' the antiferromagnetic order (in units of magnetization). The coefficient y_i^{π} changes sign from one sublattice to another. The "Weiss" coefficients $W(T)$ and $W'(T)$ are slowly temperature-dependent and obey $dW/dT>0$; $dW'/dT>0$. A phase transition is found in three dimensions, but not in one or two dimensions. For spin ½ lattices of simple cubic, body-centred cubic, and face-centred cubic type, the ferromagnetic transition temperature T_c in units kT_c/J is found to be 1·98, 2·87, and 4·45, respectively. Corresponding values for the simple cubic case due

to P. R. Weiss and V. Zehler are 1·85 and 1·93 respectively. The susceptibility and the paramagnetic temperature θ are found for the three lattices. The ratio θ/T_c is found to be independent of spin with the values 1·52, 1·39, and 1·34 for the s.c.c., b.c., and f.c.c. lattices respectively. Corresponding results for the transition temperatures, susceptibility, etc., are obtained for the antiferromagnetic cubic lattices. A.

538.122 : 518.5 : 621.3.013 : 621.395.625.3

2864. Calculation of the magnetic field in the ferromagnetic layer of a magnetic drum. O. KARLQVIST. *K. Tekn. Högsk. Handl., No.* 86, 27 *pp.* (1954).

The magnetic field is calculated for the case of finite air gaps, and finite permeability in the ferromagnetic layer. Solutions are obtained by conformal mapping for $\mu = 1$ and $\mu = \infty$. These suggest a linear potential distribution between corners of the recording head. This approximation gives explicit expressions for the field, and the method is generalized to finite permeability. Expressions are given for the field on each side of the layer, and asymptotic expressions are given for the field at a large distance from the pole gap of the recording head. The inductance of the head is calculated, and measurements of variation of inductance for changes in permeability are quoted. The transient field is computed for the one-dimensional case assuming a high value of layer resistivity. The results may be used to analyse the influence on the field of permeability and head shape.

J. M. C. DUKES

538.22 : 538.632

2865. Properties of Hall generators. F. KUHRT. *Siemens-Z.*, **28,** *No.* 8, 370–6 (*Sept.*, 1954) In German.

A comprehensive review of the subject is presented. Theory of the loaded Hall generator is given and methods of compensating the magnetic-field dependence of the internal resistance are described. Details are furnished concerning the temperature-dependence of the Hall constants and of the specific resistance of In antimonide and In arsenide. Methods of increasing the power output and sensitivity by embedding the material used as generator in a material of low heat conductivity and by use of thin generator material are discussed.

A. WILKINSON

538.22 : 538.632

2866. Application of Hall generators. W. HARTEL. *Siemens-Z.*, **28,** *No.* 8, 376–84 (*Sept.*, 1954) In German.

For practical applications of Hall generators, the Hall constant of the material used should be very great and should vary very little with temperature. The material should also have a low specific resistance. These requirements are all met by the materials In antimonide and In arsenide. With plates of these materials of suitable size, a Hall voltage can be obtained large enough to drive an oscillograph element, operate a small relay or a magnetic amplifier. Arrangements are described in which a Hall generator, mounted in the air-gap between the two halves of a coil producing a magnetic field, is used to derive a voltage proportional to the product of two electrical quantities. More complex arrangements, including amplifiers, are shown for obtaining the product of 3 quantities, reciprocal values or quotients. Other applications described include regulation of the torque of a d.c. motor, measurement of large direct currents and measurement of the variation of the magnetic field between pole-piece and armature at a fixed point of the pole-piece of a d.c. machine.

A. WILKINSON

538.221

2867. The magnetic properties and their temperature dependence of ferromagnetic alloys with an order-disorder transformation. I. Ni_3Fe. T. TAOKA AND T. OHTSUKA. *J. Phys. Soc. Japan,* **9,** *No.* 5, 712–22 (*Sept.–Oct.*, 1954).

The temperature dependence of magnetic properties of Ni_3Fe have been measured at a fixed state of order. Ni_3Fe is a characteristic example of the A_3B-type ferromagnetic alloy undergoing an order-disorder transformation. Particular stress was placed on the change of magnetic properties at the order-disorder transformation temperature 490°c. Magnetization was measured with an astatic magnetometer equipped with an electric vacuum furnace enabling rapid heating of the sample. Magnetostriction was measured by a new apparatus designed to simplify manipulation of the sample at high temperatures. At a fixed state of order, the saturation magnetostriction was seen to decrease monotonically with temperature, whereas at a fixed temperature it was seen to increase with the formation of order. In particular, λ_s increases by 200%, from below 2×10^{-6} at the disordered state to $5{\cdot}8\times10^{-6}$ at the ordered state, at the order-disorder transformation point.

A.

538.221

2868. The magnetic properties and their temperature dependence of ferromagnetic alloys with an order-disorder transformation. II. Ni_3Mn. T. TAOKA AND T. OHTSUKA. *J. Phys. Soc. Japan,* **9,** *No.* 5, 723–9 (*Sept.–Oct.*, 1954).

Measurements on the change of magnetic properties with the formation of the superlattice and their temperature dependency at a fixed state of order has been carried out on the ferromagnetic alloy Ni_3Mn which shows characteristic properties different from the same A_3B-type Ni_3Fe. Measurements were made by the apparatus described in Pt I. Ni_3Mn is known to undergo an order-disorder transformation in the temperature range 600°c to 300°c. Major results obtained are: (1) the ferromagnetic Curie point increases from below room temperature at the disordered state to over 490°c at the ordered state; (2) saturation magnetostriction is very small and the temperature dependence complicated; (3) large and long magnetic after-effects were found at the intermediate states of order.

A.

538.221

2869. On the Λ-shaped ferrimagnetism of $FeS_{1\cdot10}$. T. HIRONE, S. MAEDA AND N. TSUYA. *J. Phys. Soc. Japan,* **9,** *No.* 5, 736–9 (*Sept.–Oct.*, 1954).

A Λ-shaped change in the thermomagnetic curve in iron sulphide $FeS_{1\cdot10}$ (γ-transformation) was investigated experimentally. It was found that the peak height was increased by decreasing the heating speed of the specimen. Temperature hysteresis in the thermomagnetic curves was also found at the low-temperature side of the peak. Excess specific

heat corresponding to the thermomagnetic anomaly was observed; the amount of anomalous heat absorption during the transformation was of the order of 100 cal/mol. It was concluded that the change of magnetism at the transformation is due to the ferrimagnetic distribution of ferrous and ferric ions and the change of vacant site distribution at the transformation. A.

538.221

2870. Magnetostriction of iron. L. Weil and K. Reichel. *J. Phys. Radium*, **15**, *No.* 12, 72 S–73 S (*Dec.*, 1954) In French.

Gives results of room-temp. measurements on a polycrystalline iron specimen in fields up to 8000 oersted using strain gauges. Saturation is practically complete at 5000 oersted, with $\lambda_s \fallingdotseq -9\times10^{-6}$. E. P. WOHLFARTH

538.221

2871. Negative and positive magnetocaloric effects, and the magnetic states of the compound $MnAu_2$. A. J. P. Meyer and P. Taglang. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1611–13 (*Dec.* 8, 1954) In French.

A continuation of Abstr. 1988 (1955). At a critical temperature T_c, depending on field strength, the magnetization passes through a maximum. Hence the magnetocaloric temperature change ΔT, proportional to $-(\partial I/\partial T)_H \Delta H$, changes sign at the same temperature. This effect is verified for temperatures between 14° and 130°C and fields between $6{\cdot}6\times10^3$ and $28{\cdot}1\times10^3$ Oe. Curves of ΔT against T, obtained by adiabatic demagnetization, lie above the T-axis for $T < T_c(H)$, below for $T > T_c$, and pass through a minimum at 90°C, the Curie temperature. E. P. WOHLFARTH

538.221

2872. Ferromagnetic resonance in nickel ferrite between one and two kilomegacycles. H. Suhl. Letter in *Phys. Rev.*, **97**, *No.* 2, 555–7 (*Jan.* 15, 1955).

Describes the theory of a method of measurement producing low resonance frequencies in ferrite specimens in the form of single crystal, single domain spheres or discs. For fields above a certain critical field H_c applied parallel to an axis of difficult magnetization, the magnetization vector also lies parallel to this axis and the resonance frequency is given by $\gamma(H - H_c)$ which can be made low. Results are derived for general orientations of the magnetization vector, and the effects of misalignment and residual domain structure are investigated. Results of measurements of the resonance frequency and line width are given for $Ni_{0.75}Fe_{2.25}O_4$. E. P. WOHLFARTH

538.221

2873. Band model for Hall effect, magnetization, and resistivity of magnetic metals. E. M. Pugh. *Phys. Rev.*, **97**, *No.* 3, 647–54 (*Feb.* 1, 1955).

The ordinary Hall coefficients for Cu, Ni, Co and the binary alloys of these elements agree to within a factor of two with predictions based upon the usual band model in which the number of conduction electrons per atom is postulated to be the number, $n_s = 0{\cdot}6$, of 4*s* electrons required to explain the saturation magnetization in these materials. The factor of two, however, created a dilemma, since both the magnetization data and the Hall data were accurately determined. The Hall results appeared to require that $n_s < 0{\cdot}3$ whereas the magnetization data requires that $n_s > 0{\cdot}54$. It will be shown that this dilemma disappears when the 4*s* band is considered divided into two parts in which the electrons with spins parallel to the spontaneous magnetization have much greater mobility than those with spins antiparallel. According to Mott, the antiparallel electrons have low mobility, because they can be scattered into the partially empty 3*d* band, whereas the parallel electrons cannot. It will be shown that the ordinary Hall data, the saturation magnetization data, and the resistivity data for these transition elements and their alloys, can be made understandable by employing a four-band model, consisting of two 4*s* bands and two bands from the 3*d* shell. A.

538.221 : 537.32

2874. Magneto-thermoelectric powers of nickel single crystals. N. Miyata and Z. Funatogawa. *J. Phys. Soc. Japan*, **9**, *No.* 6, 967–73 (*Nov.–Dec.*, 1954).

The magneto-thermoelectric power (change of thermoelectric power due to magnetization of ferromagnetic substances), and its temperature dependency for nickel single crystals, are measured. The $(E_m)_{100}$ and $(E_m)_{111}$, which specify the characteristic property along the directions [100] and [111] respectively, are calculated using some reasonable approximations. The true magneto-thermoelectric power depends on the orientations of the crystal and is always positive, except in the neighbourhood of the Curie point, where it is negative. It is due to additive magnetizations proportional to the external magnetic fields, and represents a maximum value near room temperature, tending to zero at 0°K and also at the Curie point. A.

538.221 : 538.652

2875. The magnetostriction constants of silicon steel. II. H. Takaki and Y. Nakamura. *J. Phys. Soc. Japan*, **9**, *No.* 5, 748–52 (*Sept.–Oct.*, 1954).

For Pt I, see Abstr. 10325 (1954). By use of long cylindrical single-crystal rods of 2·6%, 3·2% and 4·0% silicon steel with various crystallographic orientations, prepared by the Bridgman method, magnetization and magnetostriction were measured at room temperature. It was found that Kaya's law with regard to the remanent magnetization holds for these specimens and on the basis of the law their magnetostriction constants λ_{100} and λ_{111}, and also their crystal anisotropy constants K_1 were determined. In conjunction with the results of Pt I, λ_{111} and K_1 are found to decrease almost linearly with silicon content. On the other hand, λ_{100} decreases more rapidly at low silicon content, then suddenly increases at about 2% silicon and shows no considerable change up to 4% silicon. A.

538.221 : 538.652

2876. The [110] magnetostriction of some single crystals of iron and silicon–iron. E. W. Lee. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 65–71 (*Feb.*, 1955).

Using the results of a previous paper [Abstr. 6961 (1953)] on the shape of magnetization curves, the magnetostriction of single crystals of iron parallel to the [110] direction have been calculated as functions of intensity of magnetization and field strength, using

the Néel model of domain structure. It is found that the magnetostriction is dependent on crystal width in a manner analogous to that found for the magnetization curves. Measurements on three crystals of Si–Fe show good agreement with their calculated behaviour. It is shown that in general the domain vectors in the demagnetized state are not uniformly distributed along all the easy axes and the distribution varies from one crystal to another. The actual distribution is evaluated in the two cases where it is found possible. A.

538.221 : 539.23

2877. Magnetic properties of thin metallic films. A. COLOMBANI. *Mém. Sci. phys., No.* 58, 76 *pp.* (1954) In French.

An extensive review. A discussion is given of the hysteretic and related properties of thin films prepared by electrolytic deposition, thermal evaporation and cathode sputtering (including an account of the properties of thin films of hexagonal nickel). The spin wave theory of the spontaneous magnetization of films (Klein and Smith) is outlined and its experimental verification discussed. The theory of the magnetic properties of single domains is described and applied. 88 references. E. P. WOHLFARTH

538.221 : 548.74

2878. Neutron diffraction studies of the magnetic structure of alloys of transition elements. C. G. SHULL AND M. K. WILKINSON. *Phys. Rev.*, **97**, *No.* 2, 304–10 (*Jan.* 15, 1955).

Ferromagnetic disorder scattering has been found for alloys in the disordered state and magnetic superstructure scattering is observed for ordered alloys. Such magnetic scattering when combined with magnetization data offers information on the individual atomic magnetic moments present in the alloy. In general the atomic magnetic moments deviate from their pure elemental values as a function of alloy composition. Scattering data and magnetic moment information are given for members of the Fe–Cr, Ni–Fe, Co–Cr and Ni–Mn series of alloys. A.

538.222

2879. Paramagnetic resonance absorption in manganese fluosilicate diluted with magnesium ions. T. ARAKAWA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 790–4 (*Sept.–Oct.*, 1954).

Studies on fine and hyperfine structures of paramagnetic resonance absorption spectra in single crystals of manganese fluosilicate, $MnSiF_6 . 6H_2O$, diluted with Mg^{++} ions in several ratios of Mn : Mg = (1 : 20) ~ (1 : 150) are reported. This crystal, in undiluted state, has one ion in the unit cell. Measurements were made at room temperature and at 3·2 cm wavelength. It is concluded that in these diluted crystals, the unit cell contains six non-equivalent Mn^{++} ions, the surrounding crystalline fields having different orientations, and that each field has rhombic symmetry ($D = -294$ Oe, $|E| = 32$ Oe). It should be pointed out that this field is measurably different from that of a crystal diluted with Zn^{++} ions, in which the field has axial symmetry. A.

538.222

2880. Paramagnetic resonance absorption in $K_2CuCl_4 . 2H_2O$. H. ABE, K. ÔNO, I. HAYASHI, J. SHIMADA AND K. IWANAGA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 814–22 (*Sept.–Oct.*, 1954).

Single crystals of $K_2CuCl_4 . 2H_2O$ and $(NH_4)_2CuCl_4 . 2H_2O$ were examined at 7 different frequencies of microwaves (from 5·4 mm to 6·2 cm wavelengths). If there were no exchange coupling, two absorption peaks would be expected corresponding to different g-values of two dissimilar Cu^{++} ions in unit cell. Experimentally, however, only one peak can be observed at longer wavelengths, though the line width increases remarkably with decreasing wavelengths. At a wavelength of 5·4 mm two isolated peaks can be observed. These facts can be interpreted in terms of exchange interaction between dissimilar ions. The exchange energy estimated from these data is greater than $0{\cdot}1\ cm^{-1}$. On the other hand, the width for the c-axis, where the situations of two Cu^{++} groups are identical, decreases with decreasing wavelength to a value ~1/4 of that at longer wavelength. According to the treatment by Anderson and Weiss, this result may be explained by their "10/3" effect. A.

538.222

2881. A general theory of magnetic resonance absorption. R. KUBO AND K. TOMITA. *J. Phys. Soc. Japan*, **9**, *No.* 6, 888–919 (*Nov.–Dec.*, 1954).

A general expression for the frequency-dependent susceptibility of a magnetic system is derived by a quantum-statistical method based on the linear theory of irreversible processes. This fundamental equation provides a physical ground for the so-called Fourier transform method for computing the resonance line contour. The auto-correlation function, or the relaxation function of the magnetic moment, that is the Fourier transform of the absorption intensity distribution, can be expanded in terms of the perturbation energy, which is assumed to be responsible for changes of the resonance spectrum from the unperturbed distribution. A general method is shown for choosing from the expansion terms those which contribute to a particular line of interest. This is a generalization of the method of using projection operators. The customary moment method is examined from this point of view. Introducing a further assumption, the authors propose a method for computing the contour of resonance lines from the obtained expansion. This may be regarded as the quantum-mechanical formulation of the idea employed by Anderson and Weiss for the exchange narrowing problem of paramagnetic resonance. The problem of motional effect on the broadening is treated from this general point of view. Particular applications of the theory to the motional effect of the dipolar broadening in nuclear magnetic resonance and to the exchange effect in paramagnetic cases are also discussed in detail. Some basic equations such as used by Bloembergen, Purcell and Pound for the nuclear magnetic case are re-examined and corrected. A.

538.222

2882. Note on the stochastic theory of resonance absorption. R. KUBO. *J. Phys. Soc. Japan*, **9**, *No.* 6, 935–44 (*Nov.–Dec.*, 1954).

The stochastic theory of magnetic resonance absorption developed recently by P. W. Anderson is

examined further in some details. The fundamental idea of the theory is that the resonating units suffer transitions among their possible states, each of which is characterized by a proper frequency of the magnetic moment. The transition is assumed to be described by a Markoffian process. The fundamental equation for the auto-moment or the auto-correlation of the magnetic moment is rederived and transformed. Some general properties of the absorption spectrum are discussed on the basis of this equation. In particular, the narrowed spectrum for the case of rapid transition is proved to be Lorentzian with a half width determined by the equilibrium distribution of the units and the transition matrix of the Markoffian jumps. If the relaxation time of the transition is assumed to be completely degenerate, the resonance spectrum is given by

$$I(\omega)=\frac{1}{\pi}\mathrm{Re}\int\frac{P(\omega')d\omega'}{\omega_e+i(\omega-\omega')}\Big/\left[1-\int\frac{\omega_e P(\omega')d\omega'}{\omega_e+i(\omega-\omega')}\right]$$

where $P(\omega)$ is the intensity distribution in the limit of slow relaxation, $1/\omega_e$ being the relaxation time. Although this idealization is not quite physical, the result is useful for qualitative understanding of the changes in line shapes due to the motional effect. The limit of the Gaussian–Markoff case is also discussed. A.

538.222

2883. Paramagnetic resonance absorption of violanthrone and violanthrene. Y. Yokozawa and I. Tatsuzaki. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2087 (*Dec.*, 1954).

538.222

2884. On some methods of utilizing resonant cavities in paramagnetic resonance. J. Uebersfeld. *J. Phys. Radium*, **16**, *No.* 1, 78–9 (*Jan.*, 1955) In French.

Discusses the conditions for obtaining a response in paramagnetic resonance which displays either the dispersion or the absorption of the material and gives formulae for the intensity in terms of the complex χ. D. H. WHIFFEN

538.222

2885. Paramagnetism of caesium titanium alum. B. Bleaney, G. S. Bogle, A. H. Cooke, R. J. Duffus, M. C. M. O'Brien and K. W. H. Stevens. Letter in *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 1, 57–8 (*Jan.*, 1955).

Reports results of paramagnetic resonance measurements on a single crystal between 2·5° and 4·2°K, obtaining $g_{\|}=1\cdot25$, $g_{\perp}=1\cdot14$ ($\pm0\cdot02$) and line width 250 ± 50 oersted. The results are tentatively interpreted. E. P. WOHLFARTH

538.222

2886. Paramagnetic resonance absorption in [metal] graphite compounds. B. Smaller, G. R. Hennig and E. L. Yasaitis. Letter in *Phys. Rev.*, **97**, *No.* 1, 239 (*Jan.* 1, 1955).

538.222

2887. Paramagnetic resonance absorption in some Cr^{+3} complexes. L. S. Singer. *J. chem. Phys.*, **23**, *No.* 2, 379–88 (*Feb.*, 1955).

The absorptions in several trichelate complexes of Cr^{+3} have been investigated at room temperature and at 1·2 and 3·0 cm wavelengths. From single-crystal measurements on chromic acetylacetonate the orientations of the electric axes were determined and the parameters in the spin-Hamiltonian found to be $g=1\cdot983\pm0\cdot002$, $|D|=0\cdot592\pm0\cdot002\,\mathrm{cm}^{-1}$ and $|E|=0\cdot052\pm0\cdot002\,\mathrm{cm}^{-1}$. The asymmetric single absorption peak with $g=4$ found in several of the powders and in their liquid solutions is explained on the basis of the relatively large value of D associated with the individual trichelate molecules. The apparent inadequacy of the "ionic" model for several chromic compounds is also discussed. A.

538.222

2888. Paramagnetic resonance in diluted copper salts. I. Hyperfine structure in diluted copper Tutton salts. B. Bleaney, K. D. Bowers and D. J. E. Ingram. *Proc. Roy. Soc. A*, **228**, 147–57 (*Feb.* 22, 1955).

The principal values of the g-tensor and the hyperfine structure (due to interactions with the magnetic dipole and electric quadruple moments of the stable copper isotopes) have been determined in several copper Tutton salts diluted with the isomorphous zinc salts. At high dilution the residual line width is mainly due to interaction with the nuclear magnetic moments of the protons in the water of crystallization, and increased resolution is obtained by replacing these by deuterons. Crystals of the diluted copper potassium salt have been grown from heavy water, and a detailed study made of the electric quadrupole interaction. A.

538.222

2889. Paramagnetic resonance in diluted copper salts. II. Salts with trigonal symmetry. B. Bleaney, K. D. Bowers and R. S. Trenam. *Proc. Roy. Soc. A*, **228**, 157–65 (*Feb.* 22, 1955).

An interesting transition in the paramagnetic resonance spectrum has been observed for a number of cupric salts with trigonal symmetry. At room temperature only a single nearly isotropic line is observed, with a small hyperfine structure. Below a certain temperature, which depends on the salt, the spectrum is that of three kinds of copper ion each with nearly axial symmetry about one of three mutually perpendicular directions. The behaviour of this spectrum is similar to that of the copper Tutton salts in the anisotropy of the g-tensor and magnetic hyperfine structure, and in the presence of a nuclear electric quadrupole interaction. A careful analysis of the spectrum is made for $(Cu, Mg)_3La_2(NO_3)_{12}\cdot 24D_2O$. A.

538.222 : 539.152.2

2890. Paramagnetic resonance in diluted copper salts. III. Theory, and evaluation of the nuclear electric quadrupole moments of ^{63}Cu and ^{65}Cu. B. Bleaney, K. D. Bowers and M. H. L. Pryce. *Proc. Roy. Soc. A*, **228**, 166–74 (*Feb.* 22, 1955).

The previous theory of Abragam and Pryce [Abstr. 2821, 5576 (1951)] is extended to a special case of rhombic symmetry, and to include higher-order terms. The theory gives satisfactory agreement between the observed anisotropies of the g-tensor and the magnetic hyperfine structure, and shows that the size of the hyperfine structure is about 15% smaller than would be expected on the assumption that the

magnetic electron is confined to the copper ion. Comparison with the optical absorption spectrum suggests that the spin-orbit coupling is reduced by about the same amount, and the effects are explained by an overlap of the wave-function of the magnetic electron on to neighbouring water molecules. The nuclear electric quadrupole moments are found to be (in units of 10^{-24} cm^2); Cu^{63}, −0·16; Cu^{65}, −0·15, with an estimated maximum error in the theory of 20%. A.

538.222 : 539.152

2891. Environmental effect on atomic hydrogen hyperfine structure in acids. H. Zeldes and R. Livingston. Letter in *Phys. Rev.*, **96**, *No.* 6, 1702 (*Dec.* 15, 1954).

The free H atom electron resonance in $HClO_4$, H_2SO_4 and H_3PO_4 irradiated with γ-rays at 77°K shows two weak satellites. Their separation is field-dependent and corresponds to the frequency of proton resonance. Dipole-dipole coupling apparently makes possible the flipping of nearby protons and the intensity ratio 1 : 35 compared to the main fine structure lines is consistent with a second proton at 1·8 Å. D. H. WHIFFEN

538.222 : 548.7

2892. The exchange effects on the absorption spectrum by the paramagnetic crystal with anistropic *g*-factors. M. Yokota and S. Koide. *J. Phys. Soc. Japan*, **9**, *No.* 6, 953–60 (*Nov.–Dec.*, 1954).

Using the Fourier transform method developed by Kubo and Tomita, the effects of exchange interaction have been studied for the absorption spectrum of a paramagnetic crystal containing two kinds of unequivalent ions with different anisotropic *g*-factors. The analysis has been made for the two extreme cases: (i) the exchange interaction is weak and the spectrum consists of two peaks, (ii) the exchange interaction is so strong that the two lines fuse into a single peak. Comparing with the experimental data, the values of the exchange parameters are estimated for $CuSO_4 . 5H_2O$ and $K_2CuCl_4 . 2H_2O$, and reasonable results have been obtained. A.

538.224

2893. Thermal variation of the diamagnetic susceptibility of some carbon blacks between −200°C and 1000°C. A. Marchand. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1609–11 (*Dec.* 8, 1954) In French.

Extends the earlier magnetic measurements [Abstr. 4732, 8433 (1954)] to higher temperatures. The substances investigated had crystalline diameters in the range 36 to 200 Å. E. P. WOHLFARTH

538.24 : 621.318.013 : 621.395.625.3

2894. Kinetics of magnetization in some square loop magnetic tapes. C. P. Bean and D. S. Rodbell. Letter in *J. appl. Phys.*, **26**, *No.* 1, 124–5 (*Jan.*, 1955).

The essential factors controlling speed of reversal of magnetization are stated. Curves of rate of magnetization in a constant field for 65 Permalloy are shown. While flux reversals taking place under identical conditions fail to show exact reproducibility, calculated and test result indicate substantial agreement, suggesting simple crystal geometry and action which follows that of a magnetic single crystal. An alloy of 50% Ni–50% Fe, made into a tape, which presented a square hysteresis loop after cold working, behaved differently, suggesting that domains are nucleated at many places within the tape. At high driving fields, all the materials appear to reverse by domain walls moving in from the surface. H. G. M. SPRATT

538.247

2895. Measurement of the Nernst–von Ettinghausen effect with a low demagnetizing field and without rotation of the thermal gradient. R. Gaille and A. Perrier. *Helv. phys. Acta*, **27**, *No.* 6, 506–7 (1954) In French.

Describes measurements between 50° and 200°C on iron and nickel specimens in the form of rectangular blocks, the smallest dimension being parallel to the thermal gradient, the largest to the direction of measurement, and the intermediate dimension parallel to the magnetic field. The advantages of this method are outlined. E. P. WOHLFARTH

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

2896. A new electrodynamics. P. Moon and D. E. Spencer. *J. Franklin Inst.*, **257**, *No.* 5, 369–82 (*May*, 1954).

So successful have been Maxwell's equations that the electrodynamic formulations of Ampère, Weber, and Riemann have been almost forgotten. The purpose of this paper is to present a rejuvenation of the older theories, based entirely on the force between charged particles. The new formulation leads to the correct formulae for force, induced e.m.f. and radiation. In fact, it may be regarded as an alternative to Maxwell's equations, with the advantages of Galilean relativity and a closer contact with reality (charges rather than fictitious flux lines). A.

538.3 : 537.12

2897. On the motion of an electron struck by an instantaneous electromagnetic impulse. R. Cirelli. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 1, 260–2 (*Jan.*, 1955) In Italian.

The problem is treated on the basis of Caldirola's finite differences equations of motion of the electron [Abstr. 4735 (1954)]. After the action of the e.m. impulse the behaviour of the electron is identical to that found on the basis of Dirac's third order differential equation, but in the present treatment the electron does not begin to accelerate before the arrival of the impulse, as happens when the problem is treated starting from Dirac's equation. L. PINCHERLE

538.3 : 537.12

2898. On the radiation of the electron in classical electrodynamics. P. Caldirola. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 1, 269–71 (*Jan.*, 1955) In Italian.

Further remarks following on two previous notes [Abstr. 4735 (1954), 732 (1955)]. An expression is found for the power of the radiation. L. S. GODDARD

538.522

2899. Electromagnetic interactions and couples [torques] of radiation. R. Reulos. *Helv. phys. Acta*, **27**, *No.* 6, 491–3 (1954) In French.

The derivation of the formula for the torque exerted by one loop carrying an electric current on another is sketched. A 4×4 tensor for a torque expressed in terms of electric and magnetic field strength components appears at the end of the note. For details reference is given to R. Reulos, *Recherches sur la théorie des corpuscules*, Annales de l'Institut Fourier, **5**. W. J. SWIATECKI

538.54 : 621.365.5

2900. The electromagnetic heating of thin layers of conductors and semiconductors: some generalizations on the problem of determining the ideal thickness. M. Gourceaux. *C.R. Acad. Sci. [Paris]* **239**, *No.* 23, 1607–9 (*Dec.* 8, 1954) In French.

General equations are presented for the optimum thickness for the cases of a thin layer in the form of an infinitely long cylinder and for a spherical layer. D. G. AVERY

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 537.525.8

2901. Noise of gas discharge plasma. S. Kojima, K. Takayama and A. Shimauchi. *J. Phys. Soc. Japan*, **9**, *No.* 5, 802–4 (*Sept.–Oct.*, 1954).

The noise of a "quiet" plasma has been studied in the frequency range between 1 Mc/s and 10 Mc/s. The observed noise consisted of thermal noise and current noise. The thermal noise was constant throughout the frequency region. The electron temperature determined from the noise agreed with the temperature measured by the method of double probes. The current noise had the frequency dependency expressed by the law of $1/f$. These results show that plasma noise is similar to semiconductor noise. A.

538.566

2902. Elliptical polarization of an electromagnetic wave. M. Bouix. *Ann. Télécomm.*, **9**, *No.* 12, 345–51 (*Dec.*, 1954) In French.

For previous part, see Abstr. 2029 (1955). The paper is the last of three discussing the properties of elliptically polarized waves and radiators. The gain and effective surface area of an aerial are defined. The conditions for maximum gain and the direction of stationary polarization are established. The relation between the gain and the effective surface area are then examined in considerable detail for the case of arbitrary polarization. J. M. C. DUKES

538.566

2903. The edge conditions and field representation theorems in the theory of electromagnetic diffraction. A. E. Heins and S. Silver. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 1, 149–61 (*Jan.*, 1955).

The diffraction of electromagnetic waves passing through an aperture in a perfectly conducting screen of infinite extent is considered with reference to the precise specification of the boundary value problem which arises. The requirement that the total energy in any finite volume must be finite leads to order conditions to be satisfied by the field quantities in the neighbourhood of the edge. A knowledge of these conditions makes it possible to determine the functional form of the field in the region without recourse to the special assumptions which have been made in previous discussions. There remains an indeterminancy in the resulting integral equations of the problem, which can, however, be removed by a more detailed examination of the local behaviour of certain field components. A. T. PRICE

538.566

2904. Backscattering from wide-angle and narrow-angle cones. L. B. Felsen. *J. appl. Phys.*, **26**, *No.* 2, 138–51 (*Feb.*, 1955).

Solutions are obtained for the diffraction of the waves radiated by scalar and vector point sources on the axis of a semi-infinite cone. The scalar problems are solved by the method of characteristic Green's functions to yield directly various alternative representations whose different convergence properties are discussed; the vector problem is solved by an application of spherical transmission line theory. To evaluate the plane wave scattering observed far from the cone tip, a highly convergent contour integral representation is selected and evaluated approximately for the special case of backscattering from cones having large and small apex angles. The results for the large-angle cone exhibit the transition from a backscattered spherical wave to a plane wave as the cone degenerates into an infinite plane. A.

538.566 : 534.26

Diffraction of pulses by a circular cylinder. *See Abstr.* 2527

538.566

2905. Electromagnetic wave propagation in bounded electron beams. P. Parzen. Note in *Quart. appl. Math.*, **12**, *No.* 3, 309–12 (*Oct.*, 1954).

Maxwell's equations for electron beams are written down, and solved to give the modes of propagation in a right cylindrical waveguide completely filled with a beam having an arbitrary longitudinal time-independent velocity. A uniqueness theorem for sinusoidal fields in electron beams is proved, for the case where the current density is parallel to the electron velocity. L. S. GODDARD

538.566.2

2906. On the radio wave propagation in a stratified atmosphere. R. Yamada. *J. Phys. Soc. Japan*, **10**, *No.* 1, 71–7 (*Jan.*, 1955).

Deals with the development of Weber's functions, and their application to the solution of radiowave propagation in the form of a residue series, in the case when the modified index of refraction varies with height as $a + bh + ch^2$. A.

538.566.3

2907. The deduction of Appleton's formula for ionospheric birefringence from a non-Maxwellian magnetoionic theory. Conditions and scope of validity. R. Jancel and T. Kahan. Letter in *J. Phys. Radium*, **15**, 696–7 (*Oct.*, 1954) In French.

Using a general non-Maxwellian magnetoionic theory of Lorenz plasma [Abstr. 5594, 7808 (1953); 6745 (1954)] and making simple assumptions,

Appleton's formula for birefringence is deduced. It is here assumed that the absorption is negligible, but the same formula can be deduced from the general theory for cases where the absorption is not zero.

W. T. BLACKBAND

538.566.3

2908. The numerical solution of differential equations governing reflexion of long radio waves from the ionosphere. K. G. BUDDEN. *Proc. Roy. Soc. A*, **227**, 516–37 (*Feb.* 8, 1955).

Two methods are described for obtaining numerical solutions of the differential equations which govern the reflection of long and very long radio waves from the ionosphere at vertical or oblique incidence. Both methods have been used with the EDSAC automatic digital computer, but the paper is not concerned with the details of the EDSAC programming, nor with the large series of results that has been obtained. In the first method the first-order simultaneous equations, derived from Maxwell's equations and the constitutive relations for the ionosphere, are integrated by a step-by-step process proceeding downwards. The integrations are started from properly chosen initial solutions. From the resulting field variables at the bottom of the ionosphere a reflection coefficient matrix **R** is derived, whose elements include the familiar reflection coefficients. Two integrations are needed for each derivation of the elements of **R**. For the second method, it is shown that the formulae for **R** for a level below the ionosphere can be applied also within the ionized medium, and define a more general matrix variable whose elements are the dependent variables in a new set of differential equations. These are integrated by a step-by-step process as in the first method. The solution obtained below the ionosphere gives the required set of reflection coefficients without further calculation. Only one integration is required for each derivation. The equations are given in full for certain important special cases. A.

538.566.3 : 621.396.11

2909. Determination of the energy trajectories of a wave propagated in the ionosphere. Study of two particular cases (transparent layer). E. ARGENCE. *Ann. Geophys.*, **10**, *No.* 3, 249–53 (1954) In French.

Mathematical treatment considering propagation at (*a*) normal incidence, and (*b*) oblique incidence along the magnetic equator. Some numerical results are given for the stations Fribourg and Dakar.

G. M. BROWN

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

2910. Concerning the statistical calculation of cohesive energies of ionic crystals. P. O. FRÖMAN. *Ark. Fys.*, **9**, *Paper* 8, 93–9 (1954).

In the statistical method of calculating cohesive energies of the wave-functions of the ions in the lattice, these are approximated by a plane-wave expansion. The results depend on whether the plane waves are chosen to fit (i) the free ion Hartree–Fock functions ψ_μ, (ii) the orthogonalized functions ϕ_μ formed from linear combinations of (i), or (iii) Hartree–Fock functions Φ_μ of the ions in the lattice. Using alternative (i), and subsequently forming the orthogonalized functions ϕ_μ, an expression for the cohesive energy of the lattice is found, in which the result is not the difference between two large and almost equal terms. A discussion of the validity of the Cauchy relations shows that the different approximations can lead to contradictory conclusions.

W. M. LOMER

539.11

2911. On the cubic and hexagonal close-packed lattices. T. H. K. BARRON AND C. DOMB. *Proc. Roy. Soc. A*, **227**, 447–65 (*Feb.* 8, 1955).

The present paper was stimulated by the discovery [Abstr. 6725 (1953)] of a polymorphic transition in solid helium. A discussion is given of the relative stability of the cubic and hexagonal close-packed lattices assuming central forces of the Mie–Lennard-Jones type. Taking static lattice energy alone into account the usual laws of force favour the hexagonal close-packed lattice, the difference in energy being about 0·01%. However, lattice dynamics indicates that the equivalent Debye Θ at the absolute zero is smaller for the cubic lattice, the difference being about 1%. Hence, ignoring zero-point energy, we should expect a transition to occur from hexagonal to cubic at an elevated temperature. The estimated temperature and energy of the transition are of the same order of magnitude as those observed experimentally in solid helium. An estimate is made of the effect of zero-point energy; the results can be applied with confidence to the heavier inert gases, but can only be considered as giving a qualitative indication for helium, since anharmonic effects are of great importance in this case. For the other inert gas solids it is concluded that the experimentally observed cubic close-packing at all temperatures must be due to non-central forces. A.

539.11 : 530.145.6

2912. On the quantification of an ensemble of hard spheres. J. PHILIPPOT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 9, 944–7 (1954) In French.

The occurrence of phonons for a simple one-dimensional model of hard spheres is shown. This result is a nearly trivial consequence of the work of Tomonaga, who has proved the equivalence between a one-dimensional perfect Fermi gas and an assembly of phonons. A.

539.11

2913. Improved one-dimensional [network] model of an electron gas. Branching condition and orthogonality relation. H. KUHN. Note in *Z. Naturforsch.*, **9a**, *No.* 11, 989–90 (*Nov.*, 1954) In German.

A network model of a π-electron gas extending over n branches is considered, and improved boundary conditions are discussed. P. T. LANDSBERG

539.11

2914. Electronic band structure of solids. C. A. COULSON. *Nature* [*London*] **174**, 949–50 (*Nov.* 20, 1954).

A short report of the conference at the Radar Research Establishment, Malvern, on Sept. 27–8, 1954.

539.11

2915. Electronic structure of graphite and boron nitride. K. ARIYAMA AND S. MASE. Letter in *Progr. theor. Phys.*, **12**, *No.* 2, 244–6 (*Aug.*, 1954).

Brief discussion of the effects of inclusion of non-nearest-neighbour integrals and of different stacking schemes, on the energy bands of graphite The σ-bands of graphite and of boron nitride have been calculated by the tight-binding approximation. [See also Abstr. 2748 (1955)]. J. HAWGOOD

539.11 : 548.736.3 : 539.132

2916. Covalent boron-boron bonds in crystals of certain metal borides. I. FISCHER-HJALMARS AND S. FLODMARK. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1950 (*Nov.*, 1954).

Theoretical study of hybridizations of 2*s*, 2*p* and 3*d* B orbitals needed to give bonds in the five directions of nearest-neighbour B atoms in crystals of MeB_6, where Me is Ca, Sr, Ba, Y, etc. The 3*d* contribution is essential. It is suggested that the stability of the B lattice is due to oscillating covalent B–B bonds reinforced by valence electrons from Me ions.

J. HAWGOOD

539.11 : 548.7

2917. Energy levels of a disordered alloy. R. H. PARMENTER. *Phys. Rev.*, **97**, *No.* 3, 587–98 (*Feb.* 1, 1955).

A study is made of the one-electron energy levels of a disordered alloy by means of perturbation theory, extending the results of Nordheim and Muto. To the accuracy of first-order perturbation theory, a disordered alloy is equivalent to a particular perfect crystal, the "virtual crystal," as was shown by Muto. For a certain rather general model, the effects of second-, third-, and fourth-order perturbation theory upon this "virtual-crystal" approximation are analysed. The question of convergence of the perturbation approach is studied. A certain basic limitation of the perturbation approach is discussed, namely, the limitation to nonlocalized states. Accurate results obtained by Landauer and Helland for a hypothetical one-dimensional alloy are compared with results obtained by perturbation theory. It is pointed out that the same approach can be used with equal validity in discussing not only disordered alloys but also other types of imperfect crystals; e.g., imperfections resulting from dislocations. The most striking prediction of perturbation theory, i.e. the "tailing-off" of the density-of-states curve into a forbidden band, appears to have some experimental verification. A.

539.11 : 538.614

2918. Theory of the Faraday and Kerr effects in ferromagnetics. P. N. ARGYRES. *Phys. Rev.*, **97**, *No.* 2, 334–45 (*Jan.* 15, 1955).

Both the Faraday and (magneto-optic, polar) Kerr effects in ferromagnetics are treated on the basis of the band theory of metals. The spin-orbit interaction gives the electron wave-functions such left-right asymmetry that the "magnetic" electrons, under the action of a plane polarized light wave, produce an average current perpendicular to the plane of polarization. The polarizability and conductivity tensors are evaluated. The model is capable of describing the rotation of the plane of polarization of the light and the elliptical polarization resulting from transmission or reflection on the ferromagnetic medium. Order-of-magnitude estimates of the tensor components, based on plausible assumptions on the nature of the electronic wave-functions and the energy bands in ferromagnetics, give values that agree reasonably well with experimental results. The temperature and frequency dependence of these effects as given by the formulae is also in agreement with experiment. A.

MOLECULES 539.13

539.13

2919. Influence of adiabatic interactions on the energy transfer in molecular collisions. F. W. DE WETTE AND Z. I. SLAWSKY. *Physica*, **20**, *No.* 12, 1169–80 (*Dec.*, 1954).

A description of slow molecular collisions is given, based on the assumption that the molecular interaction can be divided into an "adiabatic" and a "non-adiabatic" part. The adiabatic interaction has in general the twofold effect of changing the relative motion of the collision partners and of perturbing their internal states. The non-adiabatic interaction gives rise to transitions between the perturbed internal states. Each of the effects due to the adiabatic interaction can contribute to an increased probability of energy transfer between the translation and the internal states. The method is applied to head-on collisions of HCl molecules with dipole-dipole interaction and of CO molecules with quadrupole-quadrupole interaction as adiabatic forces. Increases in the vibrational deactivation probabilities by factors of 4 and 2, respectively, are found as a result of these interactions. The interactions give rise only to the "acceleration" effect; they are not strong enough to induce internal perturbations. A.

539.13

2920. Contribution to the analysis of molecular interactions in compressed nitrogen and carbon monoxide. I. The molecular field in the high density gas state. L. JANSEN, A. MICHELS AND J. M. LUPTON. *Physica*, **20**, *No.* 12, 1215–34 (*Dec.*, 1954).

The thermodynamic properties of compressed nitrogen and carbon monoxide are compared at temperatures from 0°C to 150°C. The differences between the two gases are discussed on the basis of a detailed study of the intermolecular field. A.

539.13

2921. Contribution to the analysis of molecular interactions in compressed nitrogen and carbon monoxide. II. Quadrupole moments and properties of the solid states. L. JANSEN, A. MICHELS AND J. M. LUPTON. *Physica*, **20**, *No.* 12, 1235–43 (*Dec.*, 1954).

An analysis of the intermolecular field of solid nitrogen and carbon monoxide is based on experimental values of the sublimation energies of the crystals, extrapolated to 0°K. The intermolecular field is assumed to consist of a Lennard-Jones part, a part due to orientation and induction effects of the permanent dipoles (CO) and permanent quadrupoles (CO and N_2) plus a correction term for the effect of

anisotropy in the London dispersion forces. The orientation and induction effects are evaluated for four shells of molecules around a central molecule. The values of the quadrupole moments calculated in this way are found to agree well with those determined recently from microwave spectra. A.

539.13

2922. Contribution to the analysis of molecular interactions in compressed nitrogen and carbon monoxide. III. Quadrupole orientation and induction effects at high temperatures. L. JANSEN, A. MICHELS AND J. M. LUPTON. *Physica*, **20**, *No.* 12, 1244–9 (*Dec.*, 1954).

With the values of the quadrupole moments of nitrogen and carbon monoxide, as determined in Pt II, the analysis of molecular interaction at high densities is concluded. Neither the quadrupole orientation, nor quadrupole induction or dipole-quadrupole orientation energies contribute significantly to the internal energy of these gases at high temperatures. The calculations are followed by a summary of the main results of this analysis. A.

539.13 : 533.7

2923. Forces between unlike molecules and the properties of gaseous mixtures. E. A. MASON. *J. chem. Phys.*, **23**, *No.* 1, 49–57 (*Jan.*, 1955).

The intermolecular potentials for a number of pairs of unlike molecules have been calculated from the known potentials for pairs of like molecules, by means of semi-empirical combination rules. The intermolecular potential used was of the exp-six form, $\phi(r) = \varepsilon/(1 - 6/\alpha)[(6/\alpha)e^{\alpha(1-r/r_m)} - (r_m/r)^6]$. The validity of the combination rules were tested by calculating a number of properties of binary gas mixtures for comparison with experimental values. The resulting agreement was quite reasonable, and it was concluded that the combination rules can be used with some confidence. A.

539.132

2924. Integrals occurring in problems of molecular structure. A. DALGARNO. *Math. Tables Aids Comput.*, **8**, 203–12 (*Oct.*, 1954).

Bibliographical review, mainly concerned with two-centre integrals and their reduction to auxiliary integrals. The scope of each of the tables of 2-centre integrals published from 1943 to early 1954 is indicated, and the parameter values given. 90 refs.

J. HAWGOOD

539.132

2925. A quantum mechanical study of the fluorine molecule. H. DINGER. *Ark. Fys.*, **8**, *Paper* 53, 527–50 (1954).

The dissociation energy and the atomic distance of the fluorine molecule have been computed assuming two valency electrons according to (i) the method of Heitler–London–Slater–Pauling (HLSP), and (ii) the molecular orbit (MO) method. The potential curves have been constructed and the values obtained have been compared with the experimental data. It is shown that the agreement is fairly good. By use of all 2 *p*-electrons in both atoms the energy parameters for the electron configurations $\sigma_g^2\pi_u^4\pi_g^4$ and $\sigma_g^2\sigma_u^2\pi_u^4\pi_g^2$ have been calculated by the MO method at varying atomic distances. The potential curves have been constructed and the energy of the molecule has been compared with the energy for the unperturbed atom. In all calculations the effective nuclear charge has been varied. It is shown that this charge depends upon the number of electrons considered and that the effective nuclear charge in all cases here dealt with is substantially smaller than charges calculated from Slater's rules. See also preliminary report in Abstr. 5834 (1954). A.

539.132

2926. On some approximation processes in the computation of bonding energy of H_2^+ ions. K. SCHÄFER. *Z. Electrochem.*, **58**, *No.* 7, 455–8 (1954) In German.

A comparison of variation methods using either hydrogen-like atomic functions as basis or the free electron functions. With a suitable effective nuclear charge the former gives more accurate results even for exchange energies in the π-bonding state of the H_2^+ ion. J. JACOBS

539.132

2927. Vibration force constants of $SiO_4(CH_3)_4$. K. IGUCHI. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1937–8 (*Nov.*, 1954).

The normal vibration frequencies of this molecule are calculated. The CH_3 groups are treated as single atoms, as rotation can be neglected at low temperature. The SiO_4 group is considered tetragonal and a somewhat simplified potential energy function is used. On the basis of group theoretical considerations the secular equation is factorized. The vibration frequencies found show satisfactory agreement with experiment. A. J. TAYLOR

539.132

2928. Benzyl-hydrogen bond dissociation energy. J. B. FARMER, I. H. S. HENDERSON, C. A. MCDOWELL AND F. P. LOSSING. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1948 (*Nov.*, 1954).

Inconsistencies are noted in the values of the ionization potential of the benzyl radical, and of the appearance potentials of $C_7H_7^+$ from toluene and dibenzyl. Reliable calculations of $D(C_6H_5CH_2 - H)$ by the direct method [see Abstr. 4780 (1954)] cannot be made. R. F. BARROW

539.132

2929. Approximate integral evaluations used in the molecular quantum mechanics of nonlinear molecules. R. S. BARKER AND H. EYRING. *J. chem. Phys.*, **22**, *No.* 12, 2072–7 (*Dec.*, 1954).

Molecular energy calculations employing actual and approximate multicentre angular-dependent integral evaluations are compared. Individual integral values for three-centre integrals used in calculations for the triangular H_3^+ ion as computed by exact methods and by the approximate formulae of Mulliken and of Rudenberg are given. The results indicate that angular and distance relations of the nuclear skeleton of this polyatomic ion are determinable at almost the identical "best" value found using the much more laborious exact integral calculations. The energies of the approximate evaluations, however, indicate that once these "best" parametric values are

determined the more exact calculations must be used. The approximate evaluations of second angular derivatives of integrals that are dependent on the angular and distance relations of component molecular nuclei are also computed and compared. Use of such derivatives in determination of approximate zero-point energies, vibrational frequencies and force constants is indicated. A.

539.132

2930. Heat of formation of CF_3 and some bond dissociation energies for fluorocarbons. B. S. Rabinovitch and J. F. Reed. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2092–3 (*Dec.*, 1954).

New data from experiments on rates of reaction of Na atoms with the series CH_3Cl–CF_3Cl, with previously reported data on halogenated methanes and ethanes, give results (in kcal): $\Delta Hf(CF_3) = -120{\cdot}5$ (25°c), $D(F_3C\text{–}Cl) = 79{\cdot}5 \pm 2$, $D(F_3C\text{–}F) = 116{\cdot}5$, $D(F_3C\text{–}CF_3) = 62$, $D(F_2C\text{–}F) < 116$. J. HAWGOOD

539.132

2931. Force constants of the halides of the III and IV group elements. S. S. Mitra. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2097–8 (*Dec.*, 1954).

The force constants of the same halides of the III and IV group elements in the same period are empirically related by $k_{III}/k_{IV} = C$, where C is a constant for each halogen. For the halogen in period n, $C = 1{\cdot}043 + 0{\cdot}052n$. These relations are used to predict some force constants for iodides, and to cast doubt on the experimental result for CF. Compare Abstr. 7157 (1951) and 5836, 9447 (1954). J. HAWGOOD

539.132

2932. The normal coordinates of *N*-dimethylaminodiborane. R. G. Breene, Jr. *J. chem. Phys.*, **23**, *No.* 1, 97–103 (*Jan.*, 1955).

The multiple origin method has been utilized for the selection of initial co-ordinates for the description of the normal vibrations of *N*-dimethylaminodiborane. Symmetry considerations were then used in order to obtain symmetry co-ordinates from these MOM co-ordinates, and, under the assumption of a diagonal potential function, these co-ordinates were assigned to vibrational frequencies which have been recently reported by Mann. The valence force constants for the methyl-*N*-methyl framework vibrations were then calculated and the results compared with similar constants obtained from the dimethylamine molecule. A.

539.132 : 536.66

Heat of formation of NH(g) and the bond dissociation energy D(NH–H). *See Abstr.* 2688

539.132

2933. N^{15} isotope shift of the perpendicular bending frequency in KNO_3 and $NaNO_3$. J. C. Decius. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1941 (*Nov.*, 1954).

$NaNO_3$ of 50·50 N^{14}–N^{15} composition shows two simple sharp peaks (at 836·1 and 814·3 cm^{-1}) in the 12 μ region of its infrared spectrum, whilst KNO_3 of similar composition shows a much more complicated spectrum. Here the N^{15} region is split into two partly resolved peaks and three maxima occur in the N^{14} region. If the N^{15} concentration is increased the N^{14} region moves towards higher frequencies, the N^{15} region towards lower frequencies. In KNO_3 crystals the planes of NO_3^- ions are perpendicular to their threefold axes; in $NaNO_3$ nearest neighbours are coplanar. The difference between the spectra is explained in terms of the interaction energy of nearest neighbour dipoles. The N^{15} atoms perturb the symmetry of the lattices so that selection rules no longer hold. The dipole derivative with respect to the displacement of N perpendicular to the plane of oxygens is estimated (0·9 D/A). A. J. TAYLOR

539.132

2934. Intermolecular coupling of the out-of-plane bending mode in several carbonates. J. C. Decius. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1946 (*Nov.*, 1954).

The frequencies of the out-of-plane bending modes for $CaCO_3$, $SrCO_3$ and $BaCO_3$ have been measured, the peaks for C^{12} and C^{13} being resolved. When the position of the C^{13} peak is calculated from that of C^{12}, neglecting intermolecular coupling, good agreement is obtained for calcite, but not for aragonite or Sr or Ba. This can be explained as due to intermolecular coupling; the coupling constants and the principal force constants are calculated. Dipole-dipole coupling is suggested. Compare similar results for nitrates (preceding abstract). J. HAWGOOD

539.132

2935. Intensity of the bending mode in carbonyl sulphide. E. C. Wingfield and J. W. Straley. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1949–50 (*Nov.*, 1954).

Experiments at 26°c and 104°c enable an analysis to be made of the contributions of upper stage bands and Fermi resonance to absorption by OCS near the fundamental (19 μ). The corrected integrated absorption for the fundamental alone at N.T.P. is $(36{\cdot}0 \pm 4{\cdot}0)10^{10}$ c/sec cm. The bond moments for C–S and C–O are then 0·09 and $-0{\cdot}63$ D (both $\pm 0{\cdot}02$ D). J. HAWGOOD

539.132

2936. $J = 0 \rightarrow 1$ rotational transition of trifluoroiodomethane. F. Sterzer. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2094 (*Dec.*, 1954).

The hyperfine splitting of the $J = 0 \rightarrow 1$ transition of CF_3I was studied with a Stark modulation spectrometer at dry-ice temperature. As CF_3I is a symmetric top molecule with a quadrupole coupling constant which is larger than the rotational constant, the quadrupole interaction energy of the iodine nucleus is nearly as large as the rotational energy of the molecule for the $J = 0 \rightarrow 1$ transition, so that higher-order perturbation effects become considerable. The measured frequencies are compared with values calculated with second-order perturbation method. There is good agreement for $B = 1523{\cdot}23$ Mc/s and $eQ_q = 0{\cdot}2150$ Mc/s. The dipole moment is found to be $(1{\cdot}0 \pm 0{\cdot}1)10^{-18}$ e.s.u. cm. A. J. TAYLOR

539.132

2937. An explicit derivation for the *s* vectors in the normal coordinate treatment of molecular vibrations. R. J. Malhiot and S. M. Ferigle. *J. chem. Phys.*, **23**, *No.* 1, 30–3 (*Jan.*, 1955).

The equations $\Sigma_n s_n^i = 0$ and $\Sigma_n r_n^0 \times s_n^i = 0$, together with the gradient properties are used to derive the s vectors for the four principal types of internal motion of a polyatomic molecule. A.

539.132

2938. Calculation of energy levels for internal torsion and over-all rotation. I. CH_3BF_2 type molecules. E. B. Wilson, Jr, Chun Chia Lin and D. R. Lide, Jr. *J. chem. Phys.*, **23**, *No.* 1, 136–43 (*Jan.*, 1955).

Methods are described for calculating the energy levels for the over-all rotation and internal torsion of molecules consisting of a rigid symmetrical top attached to a rigid asymmetrical framework in such a way that the symmetry axis of the top coincides with a principal axis of the molecule. Probable examples are nitromethane and CH_3BF_2. Matrix perturbation methods are employed to obtain finite rotational secular equations valid in each of the cases: low barrier, high barrier, low asymmetry. These secular equations are modifications of the ordinary Wang equation for the rigid asymmetric rotor and can usually be solved by the continued fraction method. The symmetry groups applicable to this problem are also discussed. A.

539.132

2939. An approximate method of calculating vibrational frequencies of polyatomic molecules. S. Bratož. *J. chem. Phys.*, **23**, *No.* 1, 159–62 (*Jan.*, 1955).

A new method is developed, based on the supposition that the molecule can be considered in zero-order approximation as a weakly coupled aggregate of partial vibrating systems, the interactions between them being taken into account by a perturbation calculation. The separation of the molecule into partial systems is discussed and a comparison is made with the results of exact calculation. A.

539.132

2940. Vibrational intensities. IV. Bond moments in C_2F_6. D. G. Williams, W. B. Person and B. Crawford, Jr. *J. chem. Phys.*, **23**, *No.* 1, 179–84 (*Jan.*, 1955).

For Pt III, see Abstr. 2886 (1952). The intensities of four of the infrared-active fundamentals of C_2F_6 have been determined and interpreted in terms of the bond-moment hypothesis. The bond-moment parameters are overdetermined so that an internal check is provided. This check, supplemented by comparison with data on related molecules, shows that the bond-moment picture is a useful approximation but that it is not quantitatively reliable. A.

539.132

2941. Vibrational intensities. V. BrCl and ICl. W. V. F. Brooks and B. Crawford, Jr. *J. chem. Phys.*, **23**, *No.* 2, 363–5 (*Feb.*, 1955).

The intensity coefficients, A_1, of the fundamental vibrational bands of BrCl and ICl have been measured. From these, the derivatives p' have been calculated. An upper limit has been set for the overtone intensity coefficients, A_2, and the second derivatives p''. The values are: for BrCl, $A_1 = 105$ cm/millimole, $A_2 < 2{\cdot}5$ cm/millimole, $p' = \pm 0{\cdot}78$ debye angstrom^{-1}, $|p''| < 10$ debye angstrom^{-2}; for ICl, $A_1 = 650$ cm/millimole, $A_2 < 4$ cm/millimole, $p' = \pm 2{\cdot}1$ debye angstrom^{-1}, $|p''| < 14$ debye angstrom^{-2}. A

539.132

2942. Intensities of infra-red bands. V. Bond polar properties in dimethyl acetylene. I. M. Mills and H. W. Thompson. *Proc. Roy. Soc. A*, **228**, 287–97 (*March* 8, 1955).

The absolute intensities of all except one of the infrared fundamental vibration bands of dimethyl acetylene have been determined, and the results have been used to compute polar properties of the C–H and C–C bonds. It has been found that if the very probable assumption is made that the acetylenic carbon atoms carry a residual negative charge, the hydrogen atoms in the C–H bonds must carry a residual positive charge. The probable value of the C–H dipole is about 0·4 debye, and that of the C–C$\equiv$ bond about 1 debye. Comparisons have been made with the results of similar work with related molecules. A.

539.132 : 535.343

Vibrational spectra, force constants, and calculated thermodynamic properties of methyltrifluorosilane. *See Abstr.* 2603

539.132 : 535.343

Microwave spectrum of methylamine. *See Abstr.* 2607

539.132 : 535.343

2943. Discrepancy in the rotational constants of bromoform. G. Herrmann. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2093 (*Dec.*, 1954).

In order to investigate the discrepancy in the observations of rotational lines of bromoform, the spectrum was taken with a Stark modulation spectrograph with sensitivity 1×10^{-10} cm^{-1}. In spite of this great sensitivity no lines could be observed, and it is therefore suggested that the lines found by Kojima *et al.* [Abstr. 5009 (1952)] must be due to other sources. A. J. TAYLOR

539.132 : 535.343

2944. On the interpretation of the spectrum of bromoform. S. Kojima and K. Tsukada. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2093–4 (*Dec.*, 1954).

See also preceding abstract. On the basis of comparisons with the spectrum of $SPCl_3$ in the frequency range from 2600 Mc/s to 2900 Mc/s, where the lines between levels separated by asymmetric K-type doubling are intense for high J values, it is suggested that the lines observed in the $CHBr_3$ spectrum might not be due to the transition $J = 0 \rightarrow 1$, but that they may be asymmetric rotor lines.

A. J. TAYLOR

539.132 : 535.343

2945. Infrared spectrum and hydrogen bonding of pyrrole. P. Tuomikoski. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2096 (*Dec.*, 1954).

Further discussion of points raised in Abstr. 2616, 6393 (1952), 9457–8 (1954). Gradual solvent-induced frequency shifts of both "associated" and "unassociated" bands remain even after the effects of overlapping of these bands have been included. Such spectral data and criteria for H-bonding based on dielectric constants indicate that the NH . . . N bond is not important in pyrrole, NH . . . *ar* interaction and head-to-head association being preferred. J. HAWGOOD

539.132 : 536.7

2946. The vibrational assignment and thermodynamic properties of naphthalene. A. L. McClellan and G. C. Pimentel. *J. chem. Phys.*, **23**, *No.* 2, 245–8 (*Feb.*, 1955).

A complete vibrational assignment of naphthalene

and naphthalene-d_8 is presented. This assignment is in substantial agreement with the experimental thermodynamic properties, the product rule and the spectroscopic data. The assigned frequencies are used to calculate the thermodynamic properties of naphthalene, S^0, C_p^0, $(H^0 - E_0^0)/T$, and $-(F^0 - E_0^0)/T$ from 273·16° to 1500°K. A.

539.132

2947. Note on the branching condition in the one-dimensional free electron gas model. H. KUHN. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2098–9 (*Dec.*, 1954).

See also Abstr. 11310 (1954). Demonstrates that the new branching condition $[(d\psi_{s_1}/ds_1) + (d\psi_{s_2}/ds_2) + (d\psi_{s_3}/ds_3)]_P = K\psi_P$ (where P is the branching point), is the necessary and sufficient condition. F. LACHMAN

539.132

2948. Zeeman splitting of nuclear quadrupole resonance line of bromine. S. KOJIMA, K. TSUKADA, A. SHIMAUCHI AND Y. HINAGA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 795–801 (*Sept.–Oct.*, 1954).

With a single crystal of about 35 g, which was prepared by the pointed-bottom crucible method, Zeeman patterns of the pure quadrupole spectrum of bromine were studied. The observations were carried out in the following orientations of the magnetic fields: (1) parallel to the *b* axis of the crystal, (2) parallel to the *c* axis, and (3) about 43 deg. from the *b* axis in the *a* plane. The pattern at the *b* axis, where the magnetic field was perpendicular to all molecular bonds, consisted of four lines. This indicated the existence of asymmetry in the field gradient tensor. The asymmetry parameter η was determined as 20%. This large value was discussed from the standpoint of resonance switching of auxiliary bonds. A.

539.132

2949. Nuclear quadrupole resonances in arsenic tribromide and arsenic tri-iodide. S. KOJIMA, K. TSUKADA, S. OGAWA, A. SHIMAUCHI AND Y. ABE. *J. Phys. Soc. Japan*, **9**, *No.* 5, 805–8 (*Sept.–Oct.*, 1954).

The pure quadrupole spectra of As^{75}, Br^{79} and Br^{81} in $AsBr_3$, and of I^{127} in AsI_3 have been studied by the method of super-regenerative detection. The observed resonance frequencies yielded the following couplings: 127 Mc/s, 415 Mc/s and 1328 Mc/s for As^{75}, Br^{79} and I^{127} respectively. The spectrum of bromine in arsenic tribromide was a triplet. Above 90°c, the iodine in arsenic tri-iodide also showed a triplet, whereas below that temperature it had a single line. The asymmetry parameter of iodine was determined from the resonance frequencies. The result was 18·4% at liquid-air temperature and 14·5% at room temperature. The low couplings and the high asymmetry of iodine in arsenic tri-iodide were interpreted by the mechanism of resonance switching of the bond. A.

539.132

2950. Nuclear quadrupole interaction in HCN and DCN in the bending vibrational mode. R. L. WHITE. *J. chem. Phys.*, **23**, *No.* 2, 249–52 (*Feb.*, 1955).

The $\Delta J = 0$, $\Delta F = 0$ transition in HCN and DCN in an excited bending mode of vibration was observed to possess structure due to an asymmetry in the electric field gradient at the nitrogen nucleus coupling to the quadrupole moment of that nucleus. A selective breaking of the π-bond perpendicular to the plane of bending when the molecule assumes its ionic structure is suggested as the source of the asymmetry. A.

539.132

2951. Quadrupole coupling of the deuteron in DCCCl and DCN. R. L. WHITE. *J. chem. Phys.*, **23**, *No.* 2, 253–5 (*Feb.*, 1955).

The quadrupole coupling of the deuteron $(eqQ)_D$ was measured in DCCCl where it was found to be $+175 \pm 20$ Kc/s. A less accurate determination of the absolute value $(eqQ)_D$ in DCN yielded approximately 290 Kc/s. The field gradient, q, at the deuterium nucleus in DCCCl is $+8·85 \pm 10\% \times 10^{14}$ e.s.u. A calculation of q based on a Hund–Mulliken molecular model yields a q of the same sign as that observed but approximately twice as large, indicating the insufficiency of the model for such detailed calculations. A.

539.132

2952. On the halogen nuclear magnetic resonance of some metal halides. I. T. KANDA. *J. Phys. Soc. Japan*, **10**, *No.* 2, 85–8 (*Feb.*, 1955).

Chemical shifts of chlorine, bromine and iodine nuclear magnetic resonance of some metal halides were measured. The results indicate that the origin of the large shift is the second-order paramagnetism due to the halogen atom covalently bonded to the neighbouring metal atoms in the crystal. The degree of covalency estimated from the shift has a reasonable order of magnitude. Spin-lattice relaxation times of LiBr, AgBr and TlBr were also measured and it was revealed that they have direct correlation to the shift. From this it was concluded that the mechanism of T_1 of these crystals is the quadrupole coupling caused by the covalent bonding of the bromine atom. A.

539.132 : 536.48 : 536.631

Spin coupling and specific heat anomalies. *See Abstr.* 2686

539.132 : 538.615

2953. Zeeman splitting of nuclear quadrupole spectra of $NaBrO_3$. T. KUSHIDA, Y. KOI AND Y. IMAEDA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 809–13 (*Sept.–Oct.*, 1954).

The Zeeman effect of nuclear quadrupole resonance line in a single crystal of sodium bromate is observed in the magnetic field of 3760 gauss. The Zeeman patterns for various crystallographic orientations are investigated and they are compared with the theoretical patterns. From the observed splitting the nuclear magnetic moment of Br^{79} is calculated. The value obtained is $2·1033 \pm 0·0052$ nuclear magnetons. A.

539.132

2954. Quantum-mechanical analysis of spin-echo phenomena. T. P. DAS, A. K. SAHA AND D. K. ROY. *Proc. Roy. Soc. A*, **227**, 407–21 (*Jan.* 20, 1955).

See Abstr. 5852 (1954). Using the density-matrix concept, the theory of spin-echoes, explaining their mode of formation, the damping effects of diffusion, and the modulation effects of *J*-coupling have been worked out by a direct and concise method. The results for spin-echo amplitude without *J*-coupling have been proved to agree for any general spin, with

the classical results. The modulation effects of J-coupling and chemical shift agree with Hahn's results. A.

539.132

2955. On the divergence problem of the W.K.B. method. I. Fényes. *Acta phys. Hungar.*, **4**, *No.* 2, 133–147 (1954) In German.

It is shown that the divergence is due to the fact that the classical result is used as zero approximation for the solution of Schrödinger's equation. Thus the series expansion does not really exist. The method can be freed of divergences if an existing series is used and the dependence on h of the eigenvalue E is taken into account. A short discussion of the applicability of the general quantum conditions follows. J. JACOBS

539.132

2956. Incomplete electronic configurations. I. The molecular self-consistent field method and the study of states with incomplete shells. G. Berthier. *J. Chim. phys.*, **51**, *No.* 7–8, 363–71 (*July–Aug.*, 1954) In French.

Extension of the LCAO self-consistent field method for molecules [Roothaan, Abstr. 2887 (1952)] to states with unpaired electrons. Analysis of direct generalization shows that the main difficulties are due to using the same set of MO's for α and for β spins; this restriction is removed, so that two sets of equations for the MO's are obtained [cf. Abstr. 5856 (1954)]. The iteration process for self-consistency of the AO coefficients is carried out as for the closed-shell case, simultaneously for the two systems of equations, giving MO's orthogonal spatially within the group associated with each spin direction, but not between the two groups. The method is applied to a discussion of the biradical state. J. HAWGOOD

539.132

2957. On the definition of bond order and free valence in quantum chemistry. W. Bingel. *Z. Naturforsch.*, **9a**, *No.* 10, 824–7 (*Oct.*, 1954) In German.

See Abstr. 8499 (1954). A definition of bond order was given for molecules with an even number of π-electrons; this is here extended to the odd case. Similarly a new formula is given for free valence, and compared with that of MO theory as well as the Daudel–Pullman and Moffitt VB definitions. J. JACOBS

539.132

2958. Free electron theory, finite differences, and LCAO molecular orbitals. A. A. Frost. *J. chem. Phys.*, **23**, *No.* 2, 310–14 (*Feb.*, 1955).

Simpson first called attention to the analogy between the free electron method in finite difference form and the simple LCAO molecular orbital method for electronic energy calculation. This analogy is extended to branched molecules using both the one- and two-dimensional viewpoints and also applied to a case of two electrons in interaction. It appears that the success of the free electron method is due to this similarity to the LCAO method. A.

539.132

2959. The ionic character of diatomic molecules. B. P. Dailey and C. H. Townes. *J. chem. Phys.*, **23**, *No.* 1, 118–124 (*Jan.*, 1955).

A relation between the electronegativity difference of two bonded atoms and the ionic character of the bond is obtained for singly bonded diatomic molecules in the gaseous state. The relation is based primarily on the wide variety of nuclear quadrupole coupling constants recently measured by microwave techniques. However, dipole moments of diatomic molecules are also used and discussed. Both quadrupole coupling constants and dipole moments indicate strongly that bonds involving electronegativity differences greater than 2 are almost completely ionic. Certain effects of hybridization, overlap and polarization on considerations of ionicity are discussed. A.

539.132

2960. On the screening constants in the hydrogen molecule. S. L. Altmann and N. V. Cohan. *Trans Faraday Soc.*, **50**, *Pt* 11, 1151–8 (*Nov.*, 1954).

The suggestion has sometimes been made that a new screening constant, given for instance by the Slater rules and therefore different from that used for the covalent structures, should be introduced when including ionic structures in molecules. This is contradicted by the result obtained by Weinbaum (1933) in computing the dissociation energy of the hydrogen molecule, namely that the best value is obtained when the screening constants for both covalent and ionic structures are equal. This result is confirmed and interpreted by the present computation. It is shown that the effective nuclear charges Z which minimize the energies of an isolated ionic canonical structure and of the total ionic structure are 0·93 and 1·08 respectively, when the internuclear distance is 0·74 Å. The dangers of a too naïve application of the Slater rules (which would give $Z = 0{\cdot}7$ in the last-mentioned cases) when choosing the screening constants are pointed out and it is shown that a misuse of the concept of canonical structure should be avoided. A.

539.132

2961. Properties of the hydrogen bond. The role of lone pair electrons. W. G. Schneider. *J. chem. Phys.*, **23**, *No.* 1, 26–30 (*Jan.*, 1955).

The properties of the hydrogen bond are discussed in relation to the equivalent orbital representation of lone-pair electrons. The dependence of the energy of the hydrogen bond on the nature of the hybridized lone-pair orbital is pointed out. On the basis of point-charge models for the water and hydrogen fluoride molecules, and on the basis of a consideration of known hydrogen-bonded structures, evidence is presented to show that the directional properties of the hydrogen bond are determined largely by the directional properties of the lone-pair orbital, and that the strongest bonds result when the hydrogen bond direction is co-linear with the lone-pair orbital direction. A.

539.132

2962. Overlaps of trial functions for the hydrogen molecule. I. Ground-state character of the 1*s* AO approximations. J. Braunstein and W. T. Simpson. *J. chem. Phys.*, **23**, *No.* 1, 174–6 (*Jan.*, 1955).

The contributions of the ground-state wave-function in some of the trial functions for the hydrogen molecule have been evaluated as the overlap integrals of the trial functions with the thirteen term function of

James and Coolidge. The r.m.s. errors and mean excited state energies are presented and the results of a binding energy calculation reported. A.

539.132

2963. Overlaps of trial functions for the hydrogen molecule. II. Covalent and ionic character of H_2. J. Braunstein and W. T. Simpson. *J. chem. Phys.*, **23**, *No.* 1, 176–9 (*Jan.*, 1955).

The mutual overlaps of some of the trial functions for the hydrogen molecule are presented and their relation to the covalent and ionic character of the bond is discussed. Difficulties involved in the definition of covalent and ionic as orthogonal components of wave-functions are pointed out and contour maps indicating the shapes of some of the functions discussed are given. A.

539.132

2964. Stabilization of energy-rich molecules. I. Energy transfer with hydrogen. M. Boudart and J. T. Dubois. *J. chem. Phys.*, **23**, *No.* 2, 223–9 (*Feb.*, 1955).

The increase in fluorescence yield of β-naphthylamine vapours in the presence of foreign gases provides a new powerful method for studying energy exchange. The effect, discovered by Neporent, is analysed kinetically and the analogue of the Stern–Volmer equation for this effect is derived. Neporent's data are recalculated in the light of this analysis. Fluorescence stabilization by deuterium and sulphur hexafluoride is studied experimentally following the procedure of Neporent. It is concluded, in particular, that the vibrational and rotational modes of the hydrogen molecules are inactive in the excitation or de-excitation of vibrational energy of complex molecules. A.

539.132

2965. Energy calculations for [illegible] ion system. R. S. Barker, J. [illegible] and H. Eyring. *J. chem. Phys.*, **23**, *No.* [illegible]. S. Kojima, 955).

A study of the dependence of the [illegible] ations for the linear triatomic hydrogen ion sy[illegible], on a single polarization (electron cloud displacement) parameter g, and on two effective orbital charge parameters Z_0 and Z_m is presented. The studies, with separate screening parameters for the central and outer atomic orbitals, used normalized approximate integrals. The individual variation of Z_0, the charge associated with the outer orbitals, and of Z_m, the charge associated with the central orbital, gave little improvement of the energy calculation. From these results with approximate integrals, calculations, at this time, using the exact integrals appear unprofitable. Only exact integrals are used in the study dealing with the off-centre electron cloud parameter, g. These exact integral calculations led to an energy of $-158{\cdot}07$ kcal/mole which is $2{\cdot}74$ kcal/mole better than the best previously obtained value for this linear system. A.

539.132

2966. Configuration interaction applied to the hydrogen molecule. E. Callen. *J. chem. Phys.*, **23**, *No.* 2, 360–2 (*Feb.*, 1955).

The electronic wave-function for the hydrogen molecule has been described as a sum of three configurations, each of which is expressed in terms of one-electron symmetry orbitals, which are written as variational functions of the elliptic co-ordinates. To a state due to Coulson, made up of orbitals which are individually even under inversion, an odd-odd state was first added, thus improving the computed binding energy from $3{\cdot}535$ eV to $4{\cdot}125$ eV. The addition of a third state, of a somewhat different character, increases the binding energy to $4{\cdot}276$ eV. The experimentally observed binding energy is $4{\cdot}72$ eV. The role of the several configurations is explained in terms of the concept of spatial correlation, following the work of Lennard-Jones and co-workers. A.

539.132

2967. Self-consistent field method and the benzene molecule. C. R. Mueller. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1950–1 (*Nov.*, 1954).

Methods used for ethylene [Abstr. 3734 (1954)] are extended to single Kekulé structures of benzene, and their interaction. Three-centre semilocalized orbitals are used in a Dirac vector model approach, giving a secular equation. A second secular equation gives the coefficients of AO's in the 3-centre orbitals. Iteration leads to self-consistency. A resonance energy of 27 kcal is obtained. J. Hawgood

539.132

2968. Free electron treatment of the orientation of substituents in aromatic molecules. S. Basu. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1952 (*Nov.*, 1954).

The free-electron method is applied to the activated complex structures in *o*-, *m*- and *p*-substitution in aniline. For aniline itself the box length (conjugated path) is 6 bond lengths, for *o*-substitution 5, for *m*-, two separate unit lengths, and for *p*- a network. The result is that *m*-substitution needs much more energy than *o*-, which needs a little more than *p*-.

J. Hawgood

539.132

2969. Modified valence-bond treatment of unsaturated and aromatic compounds. G. W. Wheland. *J. chem. Phys.*, **23**, *No.* 1, 79–84 (*Jan.*, 1955).

The conventional valence-bond treatment, by being put upon a more frankly empirical basis, can be modified in such a way that the difficulties arising from the nonorthogonality of the atomic orbitals centred about different atoms are largely bypassed. Although the extension of the new treatment to molecules more complex than that of benzene is rendered impracticable by the increased mathematical difficulties, the results obtained for 1, 3-butadiene, cyclobutadiene and benzene suggest that many of the essential features of the older calculations can be given a better theoretical justification than hitherto seemed possible. On the other hand, the importance of the relatively unstable structures with formal bonds appears to have been overrated. A.

539.132

2970. The effect of $3p\pi$ electrons: energy levels of ethylene. J. Jacobs. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 72–8 (*Feb.*, 1955).

The usual LCAO MO method for obtaining wave-functions of organic molecules with double bonds uses only $2p\pi$ atomic orbitals. As a refinement we include $3p\pi$ atomic functions in the basic molecular orbitals. Detailed calculations are made for ethylene,

taking into account the interaction of configurations of like symmetry. The first excitation energy is calculated to be 8·7 eV, a much improved value compared with that obtained with only $2p\pi$ orbitals. The implication for MO theory is that in any refined treatment the higher energy atomic orbitals can no longer be ignored. A list of newly computed atomic integrals is given. A.

539.132 : 535.343

2971. The electronic spectra of aromatic molecules. II. A theoretical treatment of excited states of alternant hydrocarbon molecules based on self-consistent molecular orbitals. J. A. POPLE. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 81–9 (*Feb.*, 1955).

The theoretical treatment of the electronic spectrum of benzenoid hydrocarbons given in Pt I [Abstr. 11307 (1954)] is generalized so that full account is taken of electron interaction. The method is based on the use of a self-consistent molecular orbital function for the ground state and corresponding functions for excited states. It is found that all the general features of the method of Pt I carry over, although certain accidental degeneracies are removed. Approximate numerical calculations based on the new method give support to the assignments made in Pt I. A.

539.132

2972. Resonance energy of graphite. G. S. COLLADAY. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2085–6 (*Dec.*, 1954).

Criticism and amplification of work of Barrow [Abstr. 7626 (1954)]. Comparison of "empirical" resonance energy (given here as 11 kcal/g atom) with theory should include the compression energy (8·5 kcal/g atom) needed to change ethane- and ethylene-like bonds into graphite bonds. Inclusion of overlap and resonance integrals of nearest and of second neighbours in LCAO calculation gives the relation W_R (theory) $= 0{\cdot}0663\alpha + 0{\cdot}2789\beta_1 - 0{\cdot}0112\beta_2 = 19{\cdot}5$ kcal/g. atom. J. HAWGOOD

539.132

2973. LCAO MO study of the phenomenon of thermochromism. S. L. MATLOW. *J. chem. Phys.*, **23**, *No.* 1, 152–5 (*Jan.*, 1955).

An LCAO MO calculation of the energies of the ground, planar triplet and perpendicular triplet states of bianthrone and bixanthylene indicates that the thermally excited state in the phenomenon of thermochromism is the perpendicular triplet. Because of the uncertainty of the correct values of the parameters used, the best correspondence between the calculated and observed excitation energies that could be expected is that of order of magnitude. This is shown to be the case. The nature of the variation of the calculated values with the choice of parameters is indicated. A.

539.132 : 538.113

Non-empirical calculation of the diamagnetic anisotropy of benzene. *See Abstr.* 2857

539.132 : 548.7

2974. The colours and magnetic properties of hydrated iron group salts, and evidence for covalent bonding. J. OWEN. *Proc. Roy. Soc. A*, **227**, 183–99 (*Jan.* 7, 1955).

The typical colours of paramagnetic salts containing $[M(H_2O)_6]$, $M = 3d^n$, complexes, are generally assumed to arise from optical transitions between the orbital energy levels of the $3d$ ion which are split by the crystalline electric field due to the surrounding water dipoles. The available optical absorption data are analysed using this ionic model and the associated crystal field theory, and it is shown that while experiment and theory agree fairly well, there are systematic discrepancies. In addition, the orbital level separations given by the optical spectrum are found to be smaller than those predicted from magnetic data. It is shown how these discrepancies can be accounted for by introducing weak covalent bonds into the $[M(H_2O)_6]$ complex, so that there is charge transfer between the paramagnetic ion and the attached water molecules. A.

539.132 : 548.736.3

Covalent boron-boron bonds in metal boride crystals. *See Abstr.* 2916

539.132

2975. Some theorems concerning the mutual polarizabilities of atoms and bonds in conjugated molecules. H. H. JAFFÉ. *J. chem. Phys.*, **23**, *No.* 1, 1–4 (*Jan.*, 1955).

Atom bond polarizabilities $\pi_{r,st}$ in alternant hydrocarbons (AH's) vanish identically. The calculation of $\pi_{r,st}$ in ions derived from AH's by addition or removal of one or more electrons (AHI's) is discussed, and the conditions under which they vanish are examined. Mutual atom polarizabilities $\pi_{r,s}$ and mutual bond polarizabilities $\pi_{rs,tu}$ in AHI's are related to the corresponding quantities in the parent AH's. The dependence of all the polarizabilities on Coulomb and resonance integrals is examined. A.

539.132

2976. Theoretical evaluation of atomic polarizations of diatomic molecules. A. P. ALTSHULLER. *J. chem. Phys.*, **23**, *No.* 2, 256–8 (*Feb.*, 1955).

The atomic polarizations, P_A (theor.), of five diatomic molecules, HCl, DCl, HBr, NO, and CO, have been calculated from an equation derived from dispersion theory (Van Vleck, 1927), using recent data obtained from infrared dispersion and absorption intensity measurements. These P_A (theor.) values are compared with the P_A (exp.) values obtained from dielectric constant and optical refractive index measurements. The greater accuracy of the P_A (theor.) values is emphasized. The P_A (theor.) values have been used to recalculate the dipole moments, μ, of the diatomic molecules considered. A qualitative relationship is discussed between the series of $d\mu/dr$ and μ values for some of the diatomic molecules. The P_A (theor.) are calculated approximately for the gaseous alkali halides. A.

539.132

2977. High-speed machine computation of ideal gas thermodynamic functions. I. Isotopic water molecules. A. S. FRIEDMAN AND L. HAAR. *J. chem. Phys.*, **22**, *No.* 12, 2051–8 (*Dec.*, 1954).

A procedure is developed for the machine computation of the partition functions for non-rigid rotating anharmonic oscillators. Vibrational-rotational coupling terms and low-temperature rotational corrections are included. A general code has been designed to permit the calculation of the ideal gas

thermodynamic functions for a large variety of molecular structures on the National Bureau of Standards Eastern Automatic Computer—SEAC. The method is illustrated by evaluating the thermodynamic functions for an asymmetric top molecule. Tables of C_p^0/R, $(H^0 - E_0^0)/RT$, $(E_0^0 - F^0)/RT$, and S^0/R have been evaluated for H_2O, HDO, D_2O, HTO, DTO, and T_2O at close intervals from 50° to 5000°K. The time required for these computations is of the order of several minutes per molecule. The results for H_2O are in good agreement with those obtained by direct summation. A.

539.133

2978. Spectroscopic evidence for stabilized HO_2 radicals. P. A. Giguère. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2085 (*Dec.*, 1954).

When D_2O_2 is prepared from D_2O vapour, the deposit formed in a liquid air trap shows a brown colour, which fades away on being warmed up to −120°c, evolving hydrogen. The spectrum of this deposit was examined. A few unfamiliar bands were observed: one strong one at 1305 cm^{-1}. If this is an O–O band, the atomic distance must be 1·30 Å, which is the same as the value calculated for HO_2. This might be stabilized in a glass lattice at low temperature. A. J. TAYLOR

539.133 : 541.135

2979. Relative diameter of oxygen and hydrogen molecules, using negative pressure as an indicator. L. J. Briggs. *J. chem. Phys.*, **23**, *No.* 2, 261–2 (*Feb.*, 1955).

A vertical glass tube (1 cm bore and about 100 cm long) carries at its closed upper end two opposed spherical platinum electrodes, approximately 1 and 2 mm in diameter. The lower end of the tube is bent upward in the form of a *J*, to which is attached a cylindrical reservoir. After introducing sufficient electrolyte ($1NH_2SO_4$) to more than fill the long tube, the system is evacuated and sealed off. On rotating the long tube from an inverted to a vertical position, the column of liquid remains hanging from the top of the tube, under a negative pressure (at the top), equal to the length of the column down to the meniscus, times its density, less the vapour pressure in the reservoir. The minimum electric charge required to drop the column is determined by successive trials, using a mica capacitor (adjustable in steps of 0·001 μF), which is first charged to a known potential and then connected to the electrodes through a quick-acting switch. After each drop of the column, the polarity is reversed. Hydrogen is deposited as an incomplete monomolecular film when the smaller test electrode is the cathode; oxygen, when it is the anode. The critical anodic charge was divided by 2, oxygen being bivalent. The ratio of the critical charges gives the relative number of molecules involved; and its reciprocal, the ratio of the projected areas. The mean of 9 series of measurements gave 1·022 ± 0·006 as the ratio of the diameter of the oxygen to the hydrogen molecule. Measurements by other methods range from 1·54 to 0·89. A.

539.133

2980. Microwave determination of the structure of pyridine. B. Bak, L. Hansen and J. Rastrup-Andersen. *J. chem. Phys.*, **22**, *No.* 12, 2013–17 (*Dec.*, 1954).

2-, 3- and 4-mono-deutero-pyridine have been prepared and the microwave spectra recorded. For each of the isotopic species 11–12 transitions (*Q*- and *R*-branch lines) were localized, a number of which could be identified by their Stark effect. For all three species rotational constants of high precision were calculated. The material so provided in connection with known rotational constants for ordinary pyridine is insufficient for a complete determination of the ten geometrical parameters of the molecule. Seven models with a choice of C − H distances close to the correct value (1·075–1·085 Å) were considered, one of which was shown to be consistent with electron-diffraction work and current valence theory. In this model $d(N - C(2)) = 1{\cdot}340 \pm 0{\cdot}005$; $d(C(2) - C(3)) = 1{\cdot}390 \pm 0{\cdot}005$; $d(C(3) - C(4)) = 1{\cdot}400 \pm 0{\cdot}005$ Å. The valence angles in the aromatic ring (starting with the C(6) − N − C(2) angle) are: 116° 42′; 124° 00′; 118° 36′; 118° 06′. A.

539.133

2981. Structure and barrier height of methyl mercaptan from microwave data. N. Solimene and B. P. Dailey. *J. chem. Phys.*, **23**, *No.* 1, 124–30 (*Jan.*, 1954).

The $0_{00} - 1_{01}$ rotational transitions of several isotopic species of methyl mercaptan have been observed. This has permitted a complete determination of the structural parameters of this molecule. The torsional energy levels of $C^{12}H_3S^{32}H$ and $C^{12}D_3S^{32}H$ have been approximately determined by relative intensity measurements. A sinusoidal barrier height has been determined which gives torsional energy levels in agreement with the observed ones. A.

539.133

2982. Statistical mechanics of flexible linear polymers. I. Moments of end-to-end distance of a polymer. N. Saitô. *J. Phys. Soc. Japan*, **9**, *No.* 5, 780–5 (*Sept.–Oct.*, 1954).

A statistical mechanical theory of the configuration of long flexible linear polymers is developed on the pearl-necklace model. The "volume effect" is taken into account, the potential between two non-neighbouring structural units being assumed to be of the rigid-sphere type. Using the method of coupling parameter and the technique of Laplace transform, the moments of end-to-end distance of polymers were obtained. In particular the average square of end-to-end distance is given by

$$\langle r^2 \rangle \simeq Nb^2 \left\{ 1 + \frac{4}{3}\sqrt{\frac{6}{\pi}}\left(\frac{a}{b}\right)^3 \left[1 + \frac{1}{5}\left(\frac{a}{b}\right)^2 + \ldots \right] \sqrt{N} \right\}$$

where N, a and b are respectively number of structural units or beads of a polymer, diameter of a bead and bond length. A.

539.133 : 530.162

2983. Monte Carlo calculation of the average extension of molecular chains. M. N. Rosenbluth and A. W. Rosenbluth. *J. chem. Phys.*, **23**, *No.* 2, 356–9 (*Feb.*, 1955).

The behaviour of chains of very many molecules is investigated by solving a restricted random walk

problem on a cubic lattice in three dimensions and a square lattice in two dimensions. In the Monte Carlo calculation a large number of chains are generated at random, subject to the restrictions of no crossing or doubling back, to give the average extension of the chain, $\langle R^2 \rangle_{Av}$ as a function of N, the number of links in the chain. A system of weights is used in order that all possible allowed chains are counted equally. Results for the true random walk problem without weights are obtained also. A.

ATOMS . NUCLEUS . ISOTOPES 539.15

539.15

2984. Experimental model for the display of magnetic nuclear resonance phenomena. G. Brunner and A. Lösche. *Z. Phys.*, **139**, *No.* 5, 569–77 (1954) In German.

Analogous electronic resonant circuits designed to imitate nuclear resonance signals for both slow and rapid passage through resonance are analysed and shown to resemble the nuclear resonance case very closely. D. H. WHIFFEN

539.15

2985. Remarks on the organization of the electron cloud and the nucleus of atoms. R. Daudel, S. Odiot and H. Brion. *J. Phys. Radium*, **15**, *No.* 12, 804–9 (*Dec.*, 1954) In French.

The ideas of electron "cells" and shells, and the analogy with nuclear shells, discussed in Abstr. 2034, 2608 (1953), 697, 1516, 1535, 3767, 4851, 8536, 10431 (1954), etc., are assembled. J. HAWGOOD

539.152.1

2986. Nuclear structure and nuclear transformations. J. H. D. Jenson. *Z. Elektrochem.*, **58**, *No.* 8, 546–53 (1954) In German.

A review of present views on nuclear structure and the role of models adopted in the several theories. Reference is made to the "periodic system" of nuclei and the shell model for them, imitating the atomic model. The implications for this model of the strong spin-orbit coupling are discussed. J. JACOBS

539.152.1

2987. Nuclear binding energies with illustrations from mass spectrography. J. Mattauch. *Z. Elektrochem.*, **58**, *No.* 8, 553–9 (1954) In German.

Different types of atom are considered as nuclear-chemical compounds of two nucleons each of atomic weight 1. In mass-spectrographs of high resolving power (with double focusing), however, molecules and atoms of the same mass number can be separated. The distances between the multiplet lines give directly the binding energies of successive nucleons bound to a given initial nucleus. J. JACOBS

539.152.1

2988. Specific heat of the nucleus in the gas-drop model. G. Süssmann. *Z. Phys.*, **139**, *No.* 5, 533–42 (1954) In German.

The Fermi-gas entropy and the decrease in this arising from collective motion are calculated. The specific heats of an ideal Fermi gas, a Fermi gas with subsidiary conditions (as necessary in the nucleus with collective motion) and of the surface oscillations are calculated. G. E. BROWN

539.152.1

2989. The degrees of freedom of the gas-drop model of the nucleus. G. Süssmann. *Z. Phys.*, **139**, *No.* 5, 543–68 (1954) In German.

The division of the degrees of freedom between the individual and collective motions is discussed. The total motion can be separated by a transformation of the Schrödinger equation into a collective motion (of the A. Bohr–Reifman, or Hill–Wheeler type) and an individual motion which must satisfy auxiliary conditions determined by the collective motion and, therefore, has fewer than $3A$ degrees of freedom. G. E. BROWN

539.152.1

2990. Some implications of a smaller nuclear radius. W. Low. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 337–47 (*March*, 1954; publ. *June*, 1954).

Using the collective particle model, it is shown that a reduced nuclear radius gives improved values of quadrupole moments, M–4 transition probabilities, ratio of distortion factor as deduced from quadrupole moments to that deduced from first excited states of even-even nuclei, and isotope shift anomalies. P. T. MATTHEWS

539.152.1

2991. Nuclear shell numbers in light elements. G. Z. Shah and K. M. Gatha. Letter in *Curr. Sci.*, **23**, *No.* 7, 215–16 (*July*, 1954).

The validity of the proposed nuclear density distribution for light elements [Abstr. 11317 (1954)] has been tested using the correlation between the nuclear density distribution and nuclear shell numbers established by Born and Yang, and by Yang; an approximate consistency was found. A. O. STANESBY

539.152.1

2992. Reliability of the semi-empirical mass formula in the calculation of neutron binding energy. M. Mohiuddin. Letter in *Curr. Sci.*, **23**, *No.* 11, 356–7 (*Nov.*, 1954).

Neutron binding energies are calculated from the semi-empirical formula, and compared with experiment. The results are in good agreement when shells are nearly full, but give large errors after the closing of a shell. P. T. MATTHEWS

539.152.1

2993. On the proton distribution in heavy nuclei. K. Wildermuth. *Z. Naturforsch.*, **9a**, *No.* 12, 1047–50 (*Dec.*, 1954) In German.

The range of the proton distribution is shown to be smaller than that of the neutron distribution as a result of: (*a*) the greater potential barrier (Coulomb repulsion); (*b*) the steeper rise of the potential for the protons. G. E. BROWN

539.152.1

2994. Spin orbit coupling and the mesonic Lamb shift. E. W. Laing. Letter in *Phil. Mag.*, **46**, 106–8 (*Jan.*, 1955).

Corrections are obtained to the spin-orbit coupling deduced by Chisholm and Touschek [Abstr. 6172 (1953)] from the self-energy, due to pseudoscalar

mesons, of a nucleon in a scalar potential well. These change the sign, but not the order, of the previous result. The author stresses that there are other corrections of the same order not yet included.

P. T. MATTHEWS

539.152.1

2995. Deuteron stripping and the problem of nuclear radii. L. N. COOPER AND W. TOBOCMAN. Letter in *Phys. Rev.*, **97**, *No.* 1, 243–4 (*Jan.* 1, 1955).

The difference in the effective radii for neutron and proton distributions in nuclei could be studied by comparing the reduced widths γ_p, γ_n in (d, p) and (d, n) reactions. For $R_n = 1{\cdot}4A^{\frac{1}{3}} \times 10^{-13}$, $R_p = 1{\cdot}2A^{\frac{1}{3}} \times 10^{-13}$ an estimate gives $\gamma_p/\gamma_n \sim \frac{1}{6}$.

W. J. SWIATECKI

539.152.1

2996. Energy of the ground state of Li^6. J. IRVING AND D. S. SCHONLAND. *Phys. Rev.*, **97**, *No.* 2, 446–50 (*Jan.* 15, 1955).

The binding energy of Li^6 is calculated by using a wave-function of the exponential type with a central Yukawa interaction, both neutral and symmetric exchange characters being considered. The neutral interaction leads to a large excess binding energy whereas the symmetric case gives much too small a value, for a particular set of nuclear parameters. The contribution to the energy from the central part of the neutral and symmetric types of Pease–Feshbach interaction is also determined. A.

539.152.1

2997. Dynamics of nuclear deformation. D. R. INGLIS. *Phys. Rev.*, **97**, *No.* 3, 701–6 (*Feb.* 1, 1955).

The droplet model of collective nuclear motions is ordinarily based on the assumption of classical irrotational fluid flow and has been used to obtain both the rotational properties of nuclei associated with a circulating surface wave and the vibrational properties of a surface deformation, though only the rotational results are confirmed experimentally. As a partial justification of the irrotational assumption, the energy of collective rotation of a closed-shell nucleus has been derived from nucleon wave-functions in an earlier paper. The vibrational problem is here similarly treated and it is shown that, in contrast to the case of rotation, the vibrational distortion of a closed-shell nucleus is so rapid that the adiabatic treatment used is not valid. The potential energy of distortion calculated with phenomenological nuclear forces is not very different from that calculated by use of the deformed three-dimensional oscillator potential, which verifies that the latter is a fairly good approximation to a "self-consistent field" for a deformed closed-shell nucleus. A.

539.152.1

2998. Matrix elements in superallowed transitions. M. BOLSTERLI AND E. FEENBERG. *Phys. Rev.*, **97**, *No.* 3, 736–42 (*Feb.* 1, 1955).

The nuclear matrix element for superallowed transitions between two states of an isobaric spin multiplet can be expressed in terms of a diagonal matrix element of the spin operator difference $S_n - S_p$. Known theoretical results on the nuclear matrix element in image transitions are summarized and the methods which have proved useful in the study of image transitions are extended to superallowed transitions within the lowest $T = 1$ isobaric spin multiplet in the $4n$ series. Experimental results indicate the actual occurrence of such transitions in Na^{20}, Al^{24}, P^{28}, Cl^{32} and Sc^{40}. A.

539.152.1 : 539.163.2

2999. Energy levels of Rh^{103} from the decay of Pd^{103} and Ru^{103}. B. SARAF. *Phys. Rev.*, **97**, *No.* 3, 715–20 (*Feb.* 1, 1955).

The decay schemes of Pd^{103} and Ru^{103} have been studied with the use of two scintillation spectrometers in coincidence. It has been observed that the electron capture activity of Pd^{103} is accompanied by faint γ-radiation having the several quantum energies of 40, 65, 300, 365 and 495 keV with absolute intensities per disintegration of 1×10^{-3}, 4×10^{-5}, $1{\cdot}2 \times 10^{-4}$, $6{\cdot}6 \times 10^{-4}$ and 1×10^{-4}. The γ-rays of energy 65 and 300 keV were found to be in coincidence. The inner bremsstrahlung spectrum associated with the capture transition leading to the 57-min isomeric level in Rh^{103} is of intensity small in comparison with that of the aforementioned γ-rays. The β-decay of Ru^{103} is accompanied by γ-rays of energies 55, 440, 495, 555 and 610 keV with absolute intensities per disintegration of 1×10^{-2}, 5×10^{-3}, $0{\cdot}90$, 5×10^{-3} and 6×10^{-2}. A β-spectrum of end point 110 ± 10 keV is coincident with the 610 keV γ-ray. A level scheme for Rh^{103} with probable orbitals has been proposed. A.

539.152.2

3000. Magnetic moments of odd nuclei in *jj* coupling. P. TEITELBAUM. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 299–303 (*March*, 1954; publ. *June*, 1954).

A general formula for the magnetic moments of odd nuclei in the lowest state is obtained making the same assumptions as in Abstr. 1842 (1953) and using fractional parentage coefficients. Generally the moments should fall between the Schmidt lines, the deviations being of the same magnitude (but opposite sign) for mirror nuclei. W. J. SWIATECKI

539.152.2

3001. On the Jensen–Mayer correction to the magnetic moment of nuclei. C. MARTY. Letter in *J. Phys. Radium*, **15**, *No.* 11, 783–4 (*Nov.*, 1954) In French.

Discusses the effect of proton spin-orbit coupling on the nuclear magnetic moment and shows it to be $\sim 0{\cdot}3$ n.m., being related to the radius and to the energy splitting of the l doublet levels. D. H. WHIFFEN

539.152.2

3002. Hyperfine splitting and the sign of the magnetic moment of Cs^{134m}. L. S. GOODMAN AND S. WEXLER. Letter in *Phys. Rev.*, **97**, *No.* 1, 242 (*Jan.* 1, 1955).

The direct hyperfine transition in Cs^{134m} has been observed at $\Delta\gamma = 3684{\cdot}5 \pm 0{\cdot}5$ Mc/s in an atomic beam experiment. Combined with the results of Abstr. 11320–1 (1954), this leads to a positive nuclear magnetic moment. See also abstract following.

W. J. SWIATECKI

539.152.2

3003. Nuclear hyperfine structure interaction in 3·1-hr Cs^{134m}. D. A. GILBERT AND V. W. COHEN. Letter in *Phys. Rev.*, **97**, *No.* 1, 243 (*Jan.* 1, 1955).

An experiment similar to that of the preceding

abstract gave $\Delta\nu = 3684{\cdot}594 \pm 0{\cdot}020$ Mc/s, confirming the pos. sign of the magnetic moment.

W. J. SWIATECKI

539.152.2 : 538.222

3004. Nuclear spins and ratio of magnetic moments of europium 151 and 153. B. BLEANEY AND W. LOW. Letter in *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 1, 55–6 (*Jan.*, 1955).

Using Eu in SrS phosphors the spins 5/2 were confirmed and $\mu Eu^{151}/\mu Eu^{153}$ found to be $2{\cdot}235 \pm 0{\cdot}03$ by paramagnetic electron resonance at 3 cm.

D. H. WHIFFEN

539.152.2 : 538.222

Electric quadrupole moments of Cu^{63} and Cu^{65}. *See Abstr.* 2890

539.152.2 : 539.89 : 532.72

Nuclear magnetic resonance in liquids under high pressure. *See Abstr.* 2472

539.153

3005. The competition between the low configurations in the spectra of the iron group. G. RACAH. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 290–8 (*March*, 1954; publ. *June*, 1954).

The orders of the configurations d^n, $d^{n-1}s$, $d^{n-2}s^2$ are discussed. Theoretical formulae in terms of convenient combinations of Slater–Condon parameters are obtained for these, which reproduce the experimental behaviour well. Various parameters in the theory are determined from comparison with experiment.

G. E. BROWN

539.153

3006. The use of the forbidden lines in helium to measure the 4*F* levels, and the singlet-triplet difference. A.-M. PILON. Letter in *J. Phys. Radium*, **15**, *No.* 10, 692–3 (*Oct.*, 1954) In French.

A photoelectric recording spectrograph was used to investigate the interval $4D$–$4F$ and the intercombination line 2^3P–3^1D. The values obtained are compared with those of other workers.

J. HUGHES

539.153

3007. Exchange potential in the statistical model of atoms. C. J. NISTERUK AND H. J. JURETSCHKE. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2087–8 (*Dec.*, 1954).

Modification of the exchange potential due to Dirac (1930) removes the anomaly of a discontinuity in the electron density at a finite radius R_0. Dirac's form is used for $r < R_i$, and for $r > R_i$, a density-independent function, $\rightarrow e/r$ for large r. Variational calculation indicates R_i will be small; e.g. for Kr, $R_i < 0{\cdot}6a_0$. Thus the exchange hole remains near the nucleus even for large r, unlike that in models with shell structure.

J. HAWGOOD

539.153

3008. Approximate analytic solution of the Thomas–Fermi equation for atoms. T. TIETZ. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2094–5 (*Dec.*, 1954).

An approximation due to Brinkman, $\chi\phi \simeq$ constant [Abstr. 4762 (1954)], is used to obtain a simpler result, $\phi = a^2/(\chi + a)^2$, where a is a constant and $\chi \propto r$. Numerical comparison shows the approximation is as good as Brinkman's.

J. HAWGOOD

539.153

3009. Approximate wave functions, with exchange for Mn^{+2}. D. R. HARTREE. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 1, 126–30 (*Jan.*, 1955).

Preliminary numerical results are given for the $6S$ term of the $(3d)^5$ configuration of the Mn^{+2} ion.

G. E. BROWN

539.153

3010. Theory of hyperfine structure. C. SCHWARTZ. *Phys. Rev.*, **97**, *No.* 2, 380–95 (*Jan.* 15, 1955).

If the classical electric and magnetic interactions between atomic electrons and the nucleus are considered, a representation of the hyperfine interactions is arrived at in terms of a multipole expansion of the field potentials. Treating these noncentral interactions in first-order perturbation theory it is possible to give the form of the general interval structure and analyse for the multipole interaction constants using Racah coefficients. Pertinent matrix elements for a single valence electron are calculated relativistically. Some second-order terms of the dipole and quadrupole interactions are calculated as they affect the interpretations of the first-order octupole interaction. In this work the effect of some electronic configuration interaction is also taken into account quantitatively. Finally the values of nuclear magnetic octupole moments expected according to different models are calculated and compared with the experimental data thus far collected. Generally the measured octupole moments are in as good agreement with the values predicted by the single-particle shell model as are the corresponding dipole moments.

A.

539.153

3011. Operator equivalents and matrix elements for the excited states of rare-earth ions. B. R. JUDD. *Proc. Roy. Soc. A*, **227**, 552–60 (*Feb.* 8, 1955).

In recent work on the rare-earth double nitrates, it has been found necessary to extend the theory of crystal fields to cases of C_{3v} symmetry. Operator equivalences are given for the potentials V_4^3 and V_6^3, defined by $\Sigma z(x^3 - 3xy^2)$ and $\Sigma(11z^3 - 3zr^2)(x^3 - 3xy^2)$ respectively, and their matrix elements tabulated over a range of J (the total angular momentum) which includes the ground states of all the rare-earth ions. Operator-equivalent factors are given for certain excited levels in praseodymium and neodymium ions. and a method is described for finding these factors for levels which derive from terms that occur twice in a configuration of the form f^n. The dependence on J and J_z of the matrix elements of the crystal-field interaction between different J levels is given for the components of a crystal field with C_{3v} symmetry.

A.

539.153

3012. The theory of the spectra of europium salts. B. R. JUDD. *Proc. Roy. Soc. A*, **228**, 120–8 (*Feb.* 15, 1955).

A theoretical analysis is given of the three ^5D terms in the europium ion. The integrals F_k are discussed and the importance of F_6 is emphasized. Values of F_4/F_2 and F_6/F_2 are calculated for a hydrogenic $4f$ eigenfunction, and evidence from the praseodymium and gadolinium ions suggests it is reasonable to use these values in the case of europium. A state in L, S, L_z, S_z quantization is defined in terms of the

determinantal product states of $4f$ one-electron states, and this enables the properties of the ^5D terms to be found. By calculating the Coulomb energies of the three terms, it is shown that the ^5D term observed spectroscopically is the lowest of the three. The relative positions of the levels $^5D_0$, $^5D_1$ and $^5D_2$ that derive from this term are calculated for Russell–Saunders coupling, and a satisfactory fit is obtained with the observed spacings. In addition, the crystal fine structures of $^7F_1$ and $^5D_1$ are related to each other, and the agreement between experiment and theory is as good as can be expected. A.

539.153 : 535.33

3013. Polarization energy for 3*d* and 4*p* electrons. R. E. Trees. *Phys. Rev.*, **97**, *No.* 3, 686–9 (*Feb.*, 1955).

Meshkov has demonstrated the presence of an appreciable polarization energy associated with the combination of a $3d$ and a $4p$ electron in the $3d^2\,4p$ configuration of Ti II. He has shown that the mean deviation between theory and experiment is reduced from ± 332 K to ± 249 K when this energy is considered. It is here noted that by use of a modified form of Meshkov's approximation a further reduction to ± 180 K is produced. This modification requires only three adjustable parameters, as compared with the five required in Meshkov's original method. It is suggested that the agreement could be made even better if a breakdown of *LS*-coupling due to the closeness of three terms in this spectrum were considered. A.

539.153 : 537.56

3014. Extrapolations of electron affinities. H. O. Pritchard and H. A. Skinner. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1936 (*Nov.*, 1954).

A test of the cubic extrapolation relation between the ionization potentials per electron of ions with the same Z and different numbers of p-electrons [Margrave, Abstr. 5879 (1954)]. Least-squares calculations on the series F V–F I and Cl V–Cl I give the electron affinities of F as 78·6 (correcting Margrave, 83·2) and of Cl as 81·5 kcal/mole. These are about 10% low, but the relation gives 99% accuracy for the ionization potentials of Na II and Mg III. It fails completely for the electron affinity of O^-. J. HAWGOOD

539.153 : 537.56

3015. Extrapolation methods for electron affinities. J. L. Margrave. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1937 (*Nov.*, 1954).

Accepts correction to electron affinity of F calculated by cubic extrapolation (preceding abstract), and discusses the validity of this extrapolation method for atoms forming negative ions. For series such as Na VII–Na III, the extrapolation to Na II still involves only positive ions, but the extrapolations to F^-, Cl^- and, *a fortiori*, to O^-, neglect the important effects of electrostatic repulsion. Extrapolations for N and C are also discussed giving electron affinities of 26 and 38 kcal/mole. J. HAWGOOD

539.153.4

3016. Extension of the Hartree–Fock equations through the correlation of the electrons. P. Gombás. Note in *Acta. phys. Hungar.*, **4**, *No.* 2, 187–8 (1954) In German.

The effect of correlation is represented by a potential given in 1934 by Wigner and the effect on the ground term of the valence electron is found to be $\sim 0{\cdot}2$ eV. G. E. BROWN

539.153.4

3017. System of differential equations which are equivalent to Dirac's equation for hydrogen atom. T. Shibata. *J. Sci. Hiroshima Univ. A*, **17**, *No.* 3, 371–6 (*March*, 1954).

The solutions of a certain system of equations, considered many times previously in the same journal, are shown to be the same as the solutions of the Dirac equation for the hydrogen atom. Polar co-ordinates are used. L. S. GODDARD

539.153.4

3018. Theory of the localizability of corpuscles. II. Electronic levels of atoms and energies associated with "boxes." H. Brion, R. Daudel and S. Odiot. *J. Chim. phys.*, **51**, *No.* 7–8, 358–60 (*July–Aug.*, 1954) In French.

For Pt I, see Abstr. 10431 (1954). It is shown how to associate energies with "boxes" similar to those of orbitals in the self-consistent field theory. In simple cases they give an approximation to the ionization energies of the atom. On the other hand these box-energies can be defined on the basis of any wave-function including the exact one. J. JACOBS

539.153.4

3019. Theory of the localizability of corpuscles. III. Return to the geometrical significance of the shell concept. S. Odiot and R. Daudel. *J. Chim. phys.*, **51**, *No.* 7–8, 361–2 (*July–Aug.*, 1954) In French.

Application of the method to excited states of helium and lithium. J. JACOBS

539.153.4

3020. Theory of the localizability of corpuscles. IV. Use of the "box" concept in the study of chemical bonds. H. Brion, R. Daudel and S. Odiot. *J. chim. Phys.*, **51**, *No.* 10, 553–5 (*Oct.*, 1954) In French.

An examination of the "boxes" for the nuclear and the bond region of Li_2 shows the following electron distribution: 1 of each spin in each central "box," 1 of each spin in the bond "box." The differentiation between π- and σ-electrons is also discussed from the point of view of these "boxes." J. JACOBS

539.153.4 : 539.18

3021. Influence of volume on the polarization shift of levels in mesic atoms. G. E. Pustovalov. Letter in *Zh. éksper. teor. Fiz.*, **27**, *No.* 6(12) 758–61 (1954) In Russian.

The shift in μ-mesic atoms from vacuum polarization is calculated assuming a finite (homogeneous) nucleus. For a point nucleus the shift goes as Z^2, whereas for the finite nucleus it goes roughly linearly in Z. G. E. BROWN

539.154.2

3022. Atomic sizes and bond types in their relation to the periodic system and to the structure of the atom. S. I. Tomkeieff. *Sci. Progress*, **43**, 28–44 (*Jan.*, 1955).

Describes contour maps, in which the spiral periodic table [Abstr. 6817 (1954)] is used as a co-ordinate system for the plotting of bond radii. Various statistical parameters are calculated. J. HAWGOOD

539.155.2

3023. Studies in nuclear spectroscopy with electromagnetically separated gaseous isotopes. I. Isotope separator and sample preparation. S. THULIN. *Ark. Fys.*, **9**, *Paper* 10, 107–36 (1954).

The isotope separator of the Nobel Institute, Stockholm, is briefly discussed. Recent improvements have increased the resolving power which is now about 550 with ion currents of several μA. The collection of stable gas isotopes is discussed, mainly with reference to experience gained with the present separator. A study of saturation phenomena occurring when rare gas isotopes are collected in metal surfaces has been undertaken. Preliminary measurements show that the maximum amount of gas which can be collected in this way is very sensitive to the beam intensity at the collector. Sputtering of target material and backscattering of energetic ions from the target were found to be negligible under the experimental conditions given. The preparation of active isotopic samples for nuclear spectrometer measurements is discussed. Usually, aluminium foils of thickness 0·15 mg/cm^2 have been used as collectors. It is shown that active rare gas isotopes can be collected in formvar films of thickness 2 μg/cm^2, but the collection efficiency was, in this case, very small. The temperature stability of gaseous targets prepared by ion bombardment of metal surfaces has been studied. Rare gas targets were found to be stable below 200°c. Measurements of this kind may give information about the diffusion of gases in metals. The use of the present instrument in conjunction with nuclear measurements is illustrated [see Abstr. 3047 (1955)]. A.

539.155.2

3024. Preparation and use of Li^6 and Li^7 concentrates. A. KLEMM. *Z. Elektrochem.*, **58**, *No.* 8, 609–10 (1954) In German.

An apparatus is described for separating the isotopes, Li^6 and Li^7, by means of electrolysis of molten LiCl. It is pointed out that Li^6 concentrates are of interest for the possible increasing of the sensitivity of neutron detectors, and that naturally occurring lithium from which Li^6 has been removed would be a suitable medium (from the point of view of its very small neutron absorption) for heat transfer in a nuclear power reactor. W. GOOD

539.155.2

3025. New results in the isotopic displacement of heavy gases in the gas ultracentrifuge. G. HERTZ AND E. NANN. *Z. Elektrochem.*, **58**, *No.* 8, 612–16 (1954) In German.

The fractions of xenon drawn off at the two ends of the rotor of a gas centrifuge are enriched respectively in the heavy and light isotopes, a result which is independent of whether the samples are taken from the immediate vicinity of the axis of rotation or the periphery. It is thought probable that the end at which enrichment in the heavy isotope is found is warmer than the other end. An explanation of this phenomenon is sought in the appearance of a countercurrent circulation, the stability of which is sufficient to give rise to a separation factor 4 to 5½ times greater than the theoretical for the elementary effect. W. GOOD

539.155.2

3026. Isotope displacement on adsorption and desorption on silica gel at low temperatures and low pressures. G. A. MELKONIAN AND B. REPS. *Z. Elektrochem.*, **58**, *No.* 8, 616–19 (1954) In German.

A displacement of the abundance ratio in favour of the lighter isotope in the desorbed phase has been established for mixtures of H_2/D_2, CH_4/CD_4, and Ne^{20}/Ne^{22}, on silica gel at 78°K and 90°K; the separation factors are higher than the static factors obtained from the heat of adsorption (calculated from the adsorption isotherms). S. J. GREGG

539.155.2

3027. The chemical separation of isotopes as a problem of rectification. C. MARCHETTI. *Z. Naturforsch.*, **9a**, *No.* 12, 1012–16 (*Dec.*, 1954).

In this paper the best operation of a column for separating isotopes by chemical exchange reactions and the best cascading of a plant are discussed. The results are presented in a form directly utilizable by the plant-designer. A.

539.155.2 : 536.423.15

Vapour pressure of heavy water and separation factor of mixed waters. *See Abstr.* 2671

539.155.2 : 537.525

3028. On atom- and ion-concentration of isotopic molecules in the d.c. glow discharge and isotope enrichment in the d.c. arc. H. D. BECKEY. *Z. Elektrochem.*, **58**, *No.* 8, 611–12 (1954) In German.

Describes briefly a mass spectrometer method for studying ion species in a low-pressure glow, using a small hole in thin foil as a canal. Hydrogen discharges are studied. J. D. CRAGGS

539.155.2 : 539.172.4

3029. Mass spectrometric study of natural and neutron-irradiated chlorine. A. W. BOYD, F. BROWN AND M. LOUNSBURY. *Canad. J. Phys.*, **33**, *No.* 2, 35–42 (*Feb.*, 1955).

Using a Nier-type mass spectrometer, the isotopic composition of chlorine gas obtained from natural potassium chloride has been measured to be 75·529 ± 0·016 atom per cent Cl^{35} and 24·471 ± 0·016 atom per cent Cl^{37}, corresponding to a Cl^{35}/Cl^{37} atom ratio of 3·0865 ± 0·0027. By comparison of this result with that for chlorine gas from potassium chloride irradiated for 14 months in a high flux position of the NRX reactor, the neutron capture cross-section of Cl^{36} has been determined to be 90 ± 25 barn. This value has been calculated on the assumption that only (n, γ) reactions were significant in changing the isotopic composition of the chlorine. A.

539.155.2 : 541.124

C^{13} isotope effect in the thermodecomposition of ethyl bromide. *See Abstr.* 3210

539.155.2 : 545.822

Spectro-isotopic assay technique for lithium. *See Abstr.* 3248

539.155.4

3030. Remarks about atomic weight. A. FISCH. *Helv. phys. Acta*, **26**, *No.* 6, 495–7 (1954) In German.

The observation is made that the mass defects per particle increase from C to Ni and then decrease up to U. W. J. SWIATECKI

539.155.4

3031. Atomic masses of Ru^{98}, Ru^{99}, Os^{189}, and Os^{192}. E. M. PENNINGTON AND H. E. DUCKWORTH. Letter in *Canad. J. Phys.*, **32**, *No.* 12, 808 (*Dec.*, 1954).

These were measured using a Dempster-type mass-spectrograph: Ru^{98}, $97{\cdot}9363 \pm 4$; Ru^{99}, $98{\cdot}9378 \pm 4$; Os^{189}, $189{\cdot}0177 \pm 9$, and Os^{192}, $192{\cdot}0224 \pm 8$ atomic mass units. A. O. STANESBY

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

3032. The measurement of radiocarbon with the gas Geiger counter tube. E. BRODA AND G. ROHRINGER. *Z. Elektrochem.*, **58**, *No.* 8, 634–6 (1954) In German.

The radiocarbon is converted to carbon dioxide and used in the filling of the Geiger counter, and it is shown that this is more sensitive and accurate than the more usual methods. The paper includes discussion by K. E. Zimen on the problem of the use of proportional counters. J. M. HOUGH

539.16.08

3033. Measurement of the thorium- and radium-content of rocks using the proportional counter. F. BEGEMANN. *Helv. phys. Acta*, **27**, *No.* 5, 451–66 (1954) In German.

Methods were developed in which the activity of the emanation released during solution of the rock was measured. A. O. STANESBY

539.16.08

3034. β- and γ-sensitive apparatus for the study of radioactive deposits collected in flight. H. GARRIGUE. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 19, 1207–8 (*Nov.* 8, 1954) In French.

A 3-litre ionization chamber with gold-leaf electroscope as detector, a thin window of large area (Al $2{\cdot}7\ mg\ cm^{-2}$, $120\ cm^2$) and an air-tight system for introduction of the collected specimen. A sensitivity 7×10^{-8} g of (Ra^{226} + equilibrium products) for 1 min measuring time was found. A. O. STANESBY

539.16.08

3035. A new method for the precise comparison of the radiation from radium sources. I. CURIE. *J. Phys. Radium*, **15**, *No.* 12, 790–5 (*Dec.*, 1954) In French.

By using the known technique of balancing the currents from two identical ionization chambers it is possible to compare with great accuracy two almost equal radiation sources. This technique has now been extended to the comparison of radium sources of very different strengths by using a radon source as an intermediate standard of reference and determining the times at which each of the radium sources equal the radon source. Two types of ionization chamber are described; with the newer cylindrical type it should be possible to determine the decay period of radon to one or two parts in 10^4 and then to compare radium standard sources to one part in 1000. Other applications of the technique are described.

L. E. MUSSELL

539.16.08

3036. An instrument for the formation of visual images of ionizing radiations. W. V. MAYNEORD, H. D. EVANS AND S. P. NEWBERY. *J. sci. Instrum.*, **32**, *No.* 2, 45–50 (*Feb.*, 1955).

The apparatus described presents visual images of distributed radioactive sources. By means of image storage facilities, it is possible to build up the picture, line by line, over a long period of time and then to "read" the complete image at any convenient time thereafter. Problems of resolution and limits of detection are discussed and illustrated by photographs. A.

539.16.08 : 537.247.4

Recording integrating photoelectric and radioactive scanner for paper electrophoresis and chromatography. *See Abstr.* 2716

539.16.08 : 539.164

3037. Disintegration-interval-analysis of radio-elements. Application to RdTh. D. HIRSCHBERG. *Nuovo Cimento*, **12**, *No.* 5, 733–42 (*Nov.*, 1954). Erratum (Ser. 10) **1**, *No.* 2, 343 (*Feb.*, 1955) In French.

The method was developed for measuring the Th isotope content of marine deposits. This may be obtained, using a proportional counter, by counting the number of α-particle pulse pairs produced by the disintegration of Tn $\xrightarrow{\alpha}$ ThA $\xrightarrow{\alpha}$ (mean-life $0{\cdot}23$ sec); the choice of the pulse interval required is discussed. Sensitivity corresponds to the amount of RdTh in equilibrium with $\sim3\times10^{-9}$ g Th. RdAc will be considered later. A. O. STANESBY

539.16.08 : 778.34

3038. Contribution to the study of rapidly evolving active deposits. M. ADER. Letter in *J. Phys. Radium*, **15**, *No.* 11, 782–3 (*Nov.*, 1954) In French.

Gives an account of some observations, using photographic emulsions, on long-range particles emitted by polonium, thorium and actinium or their decay products. These particles have ranges of up to 350 μ in the emulsion and this value appears to be largely independent of the source. P. ROTHWELL

539.163

3039. Long-lived radioactive aluminium-26. J. R. SIMANTON, R. A. RIGHTMIRE, A. L. LONG AND T. P. KOHMAN. Letter in *Phys. Rev.*, **96**, *No.* 6, 1711–12 (*Dec.* 15, 1954).

A weak Al activity (~600 disintegrations/min, $\frac{1}{2}$-life $\sim 10^6$ yr) attributed to Al^{26} has been prepared by 15 MeV deuteron bombardment of Mg. Scintillation and G.M. counter measurements suggest that the principal mode of decay is by β^+ emission followed by a $1{\cdot}9$ MeV γ-ray. M. A. GRACE

539.163

3040. Radioactive decay of Cs^{134} and Cs^{134m}. G. L. KEISTER, E. B. LEE AND F. H. SCHMIDT. *Phys. Rev.*, **97**, *No.* 2, 451–6 (*Jan.* 15, 1955).

The radiations of Cs^{134} ($2{\cdot}3$ yr) and Cs^{134m} ($3{\cdot}15$ hr) have been studied in a high-resolution β-ray spectrometer. The γ-rays of Cs^{134} were observed both by internal and external conversion, and coincidence rates were measured between the β-continuum and the internal conversion electrons of the stronger γ-rays. The β-spectrum of Cs^{134} appears to consist

of four, or possibly five, components. Nine γ-rays were found both by internal and external conversion; a tenth γ-ray appears only in internal conversion. A decay scheme is proposed which is reasonably consistent with the multipole order of each of the radiations as obtained from internal conversion data. A search was made for a ground- or intermediate-state β-transition from Cs^{134m}. No transition to the ground state was observed, but some indication was found for a weak transition to an excited state. A.

539.163.1

3041. The nuclide Ne^{19} and the *ft* of the mirror nuclei $Z = N - 1$. M. E. NAHMIAS. *J. Phys. Radium*, **15**, *No.* 10, 677–8 (*Oct.*); Erratum, *No.* 11, 775 (*Nov.*, 1954) In French.

The half-life of Ne^{19} was found to be 19 ± 1 sec. With $E_{\beta max} = 2{\cdot}3$ MeV this gives $\log ft = 3{\cdot}30$, which is explained by an inversion of the nuclear configuration $1d_{\frac{5}{2}} - 2s_{\frac{1}{2}}$. J. HUGHES

539.163.1

3042. Study of the period of decay of the 57 keV level connected with the disintegration of $MsTh_2$. F. SUZOR AND G. CHARPAK. *J. Phys. Radium*, **15**, *No.* 10, 682–3 (*Oct.*, 1954) In French.

The radiation from a source of $MsTh_2$ was counted with a 4π Geiger counter. A dead time variable between 2×10^{-4} and 1 sec was imposed on the counter and the counting rate measured as a function of this dead time. It was concluded that the lifetime of the 57 keV level is greater than 0·5 sec. J. HUGHES

539.163.1

3043. The half-life of Cl^{36}. R. M. BARTHOLOMEW, A. W. BOYD, F. BROWN, R. C. HAWKINGS, M. LOUNSBURY AND W. F. MERRITT. *Canad. J. Phys.*, **33**, *No.* 2, 43–8 (*Feb.*, 1955).

Cl^{36} was prepared by neutron irradiation of C.P. grade potassium chloride for 14 months in the NRX reactor. The disintegration rate of a purified sample of the irradiated material was determined by absolute β-counting with a 4π methane flow-type proportional counter. The number of Cl^{36} atoms in the sample was determined by gravimetric and mass spectrometric analysis. A value of $(3{\cdot}08 \pm 0{\cdot}03)\times10^5$ years was obtained for the half-life of Cl^{36}, assuming that the simple decay scheme is correct. A.

539.163.1

3044. Half-lives of Mn^{52} and Mn^{54}. E. W. BACKOFEN AND R. H. HERBER. *Phys. Rev.*, **97**, *No.* 3, 743 (*Feb.* 1, 1955).

Manganese activities produced by deuteron bombardment of chromium powder and radiochemically purified both by standard chemical techniques and ion-exchange chromatography, have been counted for a period of 2500 hr. The half-life of Mn^{54} is determined to be 291 ± 1 days, while that of Mn^{52} is found to be $5{\cdot}72 \pm 0{\cdot}02$ days. A.

539.163.1 : 539.172.4

3045. Radiochemical measurements of the natural fission rate of uranium. P. K. KURODA AND R. R. EDWARDS. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1940 (*Nov.*, 1954).

From the known fission yields of $Sr^{89,90}$ a value of 6×10^{15} years for the total fission $\frac{1}{2}$-life of U^{238} has been determined by measuring the $Sr^{89,90}/U^{238}$ ratios in a pitchblende sample. By allowing for the contribution due to spontaneous fission, that due to neutron-induced fission was estimated at 25%.

M. A. GRACE

539.163.2

3046. The decay of As^{71}. S. THULIN, J. MOREAU AND H. ATTERLING. *Ark. Fys.*, **8**, *Paper* 22, 219–28 (1954).

The decay of 65 hr As^{71} has been studied using electromagnetically separated samples. The isotope decays by *K*-capture and positron emission. The probability ratio of *K*-capture to positron emission is $2{\cdot}1 \pm 1$. It was found that at least 97% of the positrons correspond to a β^+ transition of energy 813 ± 10 keV. Two γ-rays of energies $23{\cdot}3 \pm 0{\cdot}3$ and $174{\cdot}5 \pm 0{\cdot}4$ keV were recorded by means of their conversion electrons. The $K/(L+M)$ ratios are respectively $5{\cdot}4 \pm 0{\cdot}8$ and $8{\cdot}9 \pm 1$. $\gamma - e^-$- and $\gamma - \beta^+$-coincidence measurements were performed. A decay scheme is proposed. A.

539.163.2

3047. Studies in nuclear spectroscopy with electromagnetically separated gaseous isotopes. II. Disintegration of some krypton and xenon isotopes. S. THULIN. *Ark. Fys.*, **9**, *Paper* 11, 137–95 (1954).

The present investigation deals with the decay of 9·7 hr Kr^{76}, 17·2 hr Br^{76}, 73 min Kr^{77}, 34·5 hr Kr^{79}, 4·4 hr Kr^{85m}, 9·4 yr Kr^{85}, 78 min Kr^{78}, 2·8 hr Kr^{88}, 18 min Rb^{88}, 9·2 hr Xe^{135}, 17 min Xe^{138}, and 32 min Cs^{138}. The disintegration of these isotopes has been studied by means of β- and scintillation spectrometers, as well as γ–γ and β–γ coincidence spectrometers. The nuclear spectrometer equipment and the experimental techniques are briefly discussed. Most of the isotopes were produced by uranium fission. Others were successfully prepared by nuclear reactions not reported before. Thus Kr^{76} was produced by Br^{79} $(p, 4n)$, Kr^{77} by Br^{79} $(p, 3n)$, and Kr^{79} by Br^{79} $(d, 2n)$ reactions. β- and γ-samples were prepared by means of electromagnetic isotope separation [Abstr. 3023 (1955)]. The new experimental data reported in this paper are tabulated. Decay schemes of all isotopes, except Kr^{76}, Br^{76} and Xe^{138}, are discussed on the basis of available experimental data. Those decay schemes which were considered sufficiently established have been compared with level predictions of nuclear shell theory. The extreme one-particle model seems not to account completely for any of the decay schemes presented. However, by applying recent extensions of the one-particle model, it seems possible to account qualitatively for most level schemes. A.

539.163.2

3048. The decay of Kr^{79}. S. THULIN, J. MOREAU AND H. ATTERLING. *Ark. Fys.*, **8**, *Paper* 23, 229–38 (1954).

The β-spectrum of 34·5 hr Kr^{79} has been remeasured. The positron spectrum was found to be complex, with two components of energies 598 ± 5 and 325 ± 20 keV and intensities 93 and 7% respectively. In addition to two earlier reported γ-rays the conversion electrons of 13 more γ-rays have been found. $\beta^+\gamma$- and $e^-\gamma$-coincidence measurements have been performed. Tentative level schemes are given. A.

539.163.2

3049. On heavy isotopes of arsenic. C. Ythier and G. Herrmann. *Z. Elektrochem.*, **58**, *No.* 8, 630–3 (1954) In German.

Analysis of As isotopes isolated using fast chemistry following bombardment of Se with Li + D neutrons. Amongst others a 9 min As isotope was found which decays to the 3·9 min Se^{79m} and has therefore mass 79. An (n, p) process is not possible, so it is likely that it is the daughter of the not well studied Ge^{79} formed by an (n, α) reaction. W. J. SWIATECKI

539.163.2

3050. Investigation of the disintegration $Hg^{195} \rightarrow Au^{195}$ by spectrometric β–γ coincidences. J. Brunner, J. Halter, O. Huber, R. Joly and D. Maeder. *Helv. phys. Acta*, **27**, *No.* 6, 572–6 (1954) In German.

The method is an extension of that previously described [Abstr. 5698 (1951)]. A block diagram of the electronic circuits is given. The multipolarities of many of the γ-rays in the above transition were determined, and a level scheme is given. J. HUGHES

539.163.2

3051. The decay of ^{90}Nb. Ong Ping Hok, P. Kramer and G. Meijer. *Physica*, **20**, *No.* 12, 1200–8 (*Dec.*, 1954).

Measurements have been performed on the radiations of Nb^{90} with a double-focusing spectrometer and with a scintillation spectrometer. The positon spectrum consists of three partial spectra with maximum energies of 1·500, 0·865 and 0·55 MeV. Seven γ-transitions have been deduced from the conversion electrons and the γ-scintillation spectrometer measurements. Together with the results of β–e^--coincidence measurements a probable decay scheme has been constructed. A.

539.163.2

3052. Radioactive decay of ^{103}Ru. B. de Raad, W. C. Middelkoop, B. van Nooyen and P. M. Endt. *Physica*, **20**, *No.* 12, 1278–86 (*Dec.*, 1954).

This was investigated with a scintillation spectrometer, a β-ray lens spectrometer, and by β–γ absorption coincidence measurements. With the scintillation spectrometer the X-ray and two strong γ-rays were found with the following energies and relative intensities: 20 keV (9·1%), 498 keV (100%) and 611 keV (7·8%). In addition three very weak γ-rays were observed at 53 keV (0·4%), 295 keV (0·4%) and 357 keV (0·25%). With the β-ray spectrometer the K conversion coefficient of the 611 keV γ-ray was found as (0·06 ± 0·02)%, which characterizes this transition as $E1$. Also the intensity of the weak β-component with an endpoint of 702 keV was measured as 2·9%. Absorption measurements of the β^--particles in coincidence with the 611 keV γ-ray show that there exists a third β-ray branch with an endpoint of 145 ± 35 keV, in addition to the known β-ray branches with endpoints of 217 and 702 keV. No coincidences were found between the 702 keV β-ray branch and the 53 keV γ-ray, showing that the half-life of the 53 keV level is greater than 10 μsec. The Rh^{103} level scheme deduced from these measurements is in agreement with that given by Cork *et al.*, except for the spin of the 611 keV level and of Ru^{103}. There are strong arguments that both are $J = \frac{1}{2}^+$. Also the levels found from Coulomb excitation by Heydenburg and Temmer at 295 keV ($J = 3/2^-$) and 357 keV ($J = 5/2^-$) have been confirmed from the Ru^{103} decay. A.

539.163.2

3053. On the disintegration of Mo^{99}. C. Lévi and L. Papineau. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 25, 1782–4 (*Dec.* 20, 1954) In French.

A series of β–γ and γ–γ coincidence measurements is reported, including detection of an 800 keV β-spectrum in coincidence with the 390 keV γ-ray. The Mo^{99} decay scheme is discussed. J. J. WILKINS

539.163.2

3054. A nuclear emulsion study of the radioactive decay of actinium X(^{223}Ra). B. F. Bayman and M. A. S. Ross. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 110–20 (*Feb.*, 1955).

A nuclear emulsion method has been used to obtain the absolute intensity of the conversion electron spectrum following the radioactive decay of AcX. The results have been used in conjunction with the other available knowledge about the decay to show that in the level scheme of An there are three strong transitions having energies of 144, 154 and 268 keV and probably a fourth of 122 keV, all of which are either pure $M1$ or $M1$ with only a small admixture of $E2$, All four of these transitions probably go directly to the ground state of An. Estimates of the absolute intensities of these transitions and of several other less strong transitions have been made, and it is shown that the absolute intensity of K X-ray fluorescence is at least 0·3 and probably 0·5 quanta per disintegration. A.

539.163.2

3055. Radiations of 34-day Xe^{127}. H. B. Mathur. *Phys. Rev.*, **97**, *No.* 3, 707–8 (*Feb.* 1, 1955).

The γ-rays of Xe^{127} have been studied in a sodium iodide scintillation spectrometer and by γ–γ coincidence techniques. The results support a decay scheme published previously by Bergström. A.

539.163.2

3056. Radioactivities of Zn^{69} and Zn^{71}. J. M. LeBlanc, J. M. Cork and S. B. Burson. *Phys. Rev.*, **97**, *No.* 3, 750–3 (*Feb.* 1, 1955).

The β- and γ-rays emitted in the decay of Zn^{69} and Zn^{71} have been studied with a ten-channel coincidence scintillation spectrometer. The previous assignments of a 435 keV isomeric transition to the 14 hr Zn^{69} activity and a 900 keV β-ray to the 1 hr Zn^{69} activity were confirmed. In addition to the 2·2 min activity of Zn^{71}, a previously unreported 3 hr activity of Zn^{71} was detected. A β-ray with an end-point energy of 2·4 ± 0·2 MeV and γ-rays with energies of 0·12, 0·51, 0·90, and 1·09 MeV were detected and assigned to the 2·2 min activity. A β-ray with an end-point energy of 1·5 ± 0·1 MeV and γ-rays with energies of 0·38, 0·49, and 0·61 MeV were detected and assigned to the 3 hr Zn^{71} activity. It was established that each of the γ-rays in the 3 hr activity is in coincidence with the other two γ-rays as well as the 1·5 MeV β-ray. Decay schemes for the two Zn^{71} activities are proposed. A.

539.164.2

3057. On the decay energy in artificial disintegration. R. BASU. *Indian J. theor. Phys.*, **2**, *No.* 1, 1–16 (*June*, 1954).

Kar and Kundu's theory of spontaneous α-disintegration is extended and applied to the process of artificial disintegration by considering the recoil of the residual nucleus. Modified formulae have been obtained for the upper limits of $(E_2)_{max}/(E_2)_{min}$ for the two cases (i) $\xi_1 > 0$ and (ii) $\xi_1 < 0$, where ξ_1 is the total kinetic energy in C-system at the emission radius r_1. The formulae obtained have been shown to give values in close agreement with the experimental values of the upper limits of $(E_2)_{max}/(E_2)_{min}$ for different reactions. A.

539.165

3058. Absorption in Al of the positron radiation of ^{13}N. T. GRABOWSKI AND L. NATANSON. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 8, 379–81 (1954).

This has been measured, with the results: absorption coefficient $10{\cdot}6 \pm 0{\cdot}3$ cm^2/g; practical range $0{\cdot}47 \pm 0{\cdot}01$ g/cm^2. A maximum β^+-energy of 1·185 MeV is deduced. No associated γ-radiation was detected. J. J. WILKINS

539.165

3059. Correction of continuous β-spectra due to the limited resolving power of the spectrograph. L. FEUVRAIS AND T. YUASA. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1627–9 (*Dec.* 8, 1954) In French.

Assuming that a monokinetic ray appears as a Gaussian distribution, a formula is given for deriving the true spectrum from the observed spectrum. The main effect is a correction to the end-point of the spectrum. J. J. WILKINS

539.165

3060. Beta spectrum of C^{14}. A. V. POHM, R. C. WADDELL, J. P. POWERS AND E. N. JENSEN. *Phys. Rev.*, **97**, *No.* 2, 432–3 (*Jan.* 15, 1955).

A uniform thin source enriched with C^{14} was formed by vacuum evaporation of metallic lithium which was subsequently exposed to water vapour and carbon dioxide. The Kurie plot shows no deviation from linearity above 7 keV. The maximum energy of the β-spectrum was found to be $158{\cdot}5 \pm 0{\cdot}5$ keV. A.

539.165

3061. Measurement by proportional counter of the L-capture/K-capture ratio of Ge^{71}. M. LANGEVIN. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1625–7 (*Dec.* 8, 1954) In French.

The value $0{\cdot}30 \pm 0{\cdot}02$ is deduced from observations made with a proportional counter containing propane and Ge^{71} (in gaseous form). This value is inconsistent with the value 0·10 expected theoretically. J. J. WILKINS

539.165

3062. Orbital electron excitation associated with electron capture in A^{37}. M. WOLFSBERG. Letter in *Phys. Rev.*, **96**, *No.* 6, 1712–13 (*Dec.* 15, 1954).

Double vacancies in the K-shell had been considered previously by Primakoff and Porter [Abstr. 3559 (1953)]: their formula leads to a probability for this process of $2{\cdot}8 \times 10^{-4}$ per decay. Two other processes are considered here, L-electron excitation associated with K-electron capture, and K-excitation accompanying L-capture. Their probabilities are calculated by Primakoff and Porter's method and found to be respectively 9×10^{-6} and $5{\cdot}1 \times 10^{-5}$. The total theoretical probability in the energy region of interest is thus raised to $3{\cdot}4 \times 10^{-4}$, in better agreement with the experimental value $3{\cdot}9 \times 10^{-4}$. L. PINCHERLE

539.165 : 539.166

3063. Beta-gamma angular correlation in Cl^{38}. P. MACQ. *Bull. Acad. Roy. Belgique Cl. Sci.*, **40**, *No.* 5, 802–7 (1954) In French.

The β–γ angular correlation function $1 - (0{\cdot}14 \pm 0{\cdot}06)\cos^2\theta$ for the weak β-transition to the first excited state of A^{38} has been measured using anthracene scintillation counters and absorbers to eliminate the soft β-ray group. M. A. GRACE

539.165 : 539.166

3064. Isomerism in Al^{26}. R. W. KAVANAGH, W. R. MILLS AND R. SHERR. Letter in *Phys. Rev.*, **97**, *No.* 1, 248 (*Jan.* 1, 1955).

Yields of γ-rays and (delayed) positrons have been measured from Mg^{25} targets bombarded by 850–1200 keV protons; the γ/β^+ ratio varies widely. Measurements of γ-ray spectra, γ–γ coincidences and the β^+ spectrum (end-point $3{\cdot}20 \pm 0{\cdot}05$ MeV) are also reported. A consistent energy-level scheme for Al^{26} is given, with the 6·7 sec (0^+) state at $0{\cdot}219 \pm 0{\cdot}013$ MeV excitation. J. J. WILKINS

539.165.08 : 537.533.35

Beta-spectrometer for study of β-γ coincidences. *See Abstr.* 2788

539.165.2

3065. A note on Sargent's rule in β-decay. A. MITRA. *Indian J. theor. Phys.*, **2**, *No.* 1, 25–36 (*June*, 1954).

Elements in the regions $30 \leqslant Z \leqslant 35$, $50 \leqslant Z \leqslant 55$, and $82 \leqslant Z \leqslant 92$ have been studied. It is shown that instead of drawing curves for $\log\lambda - \log E_{max}$ as by Sargent, curves should be drawn for $\log\lambda - E_{max}$ for given Z values. In that case the curves are shown to be perfectly smooth having a general upward trend. Elements giving complex spectra are also found to follow this general upward trend when the lowest value of E_{max} is considered. However, for magic numbers $Z = 50$ and $Z = 82$ double trends have been found, being upward for even neutron number but downward for odd neutron number. A.

539.165.2

3066. β spectrum of Bi^{210}(RaE) and the coupling constants of scalar and tensor interactions in β decay. G. E. LEE-WHITING. *Phys. Rev.*, **97**, *No.* 2, 463–8 (*Jan.* 15, 1955).

It is shown that the only pure states of spin 1 having magnetic moments in agreement with the measured upper limit for Bi^{210} are $(h_{9/2}; g_{9/2})_{1-}$ and $(h_{9/2}; i_{11/2})_{1-}$. The former is inconsistent with the results of an analysis of the β-spectrum of Bi^{210} with a linear combination of scalar and tensor interactions, while the latter is consistent. It follows from the acceptance of the correctness of the latter that the relative sign of the scalar and tensor coupling constants is positive. A.

539.165.8

3067. Spectrometry of recoils from neutrino emission in argon-37. A. H. SNELL AND F. PLEASONTON. Letter in *Phys. Rev.*, **97**, *No.* 1, 246–8 (*Jan.* 1, 1955).

The charge distribution (up to 5-fold ionization) and energy of ions, recoiling under neutrino emission associated with *K*-capture in A^{37}, were determined by electric and magnetic deflection. A value of ~10 eV for the recoil energy is in accord with the known disintegration energy. M. A. GRACE

539.165.8

3068. Internal and external bremsstrahlung accompanying the beta rays of P^{32}. K. LIDÉN AND N. STARFELT. *Phys. Rev.*, **97**, *No.* 2, 419–27 (*Jan.* 15, 1955).

The spectral distribution and the total energy of the internal bremsstrahlung of P^{32} were measured from 20 to 1000 keV with a NaI(Tl) scintillation spectrometer. Special care was taken to diminish and correct for bremsstrahlung from the apparatus and the surroundings. The experimental curve agrees with theory from 20 to 50 keV and in the region 50–120 keV shows a weak bump in a smoothed curve; from 120 to 500 keV the curve lies 15%, at 800 keV 45%, and at 1000 keV 70% above a theory based on allowed β-transition; thus, above 120 keV, the experimental curve disagrees with the theory for both allowed and forbidden β-transitions. The total energy per β-decay in the internal bremsstrahlung was found to exceed the calculated value by 21%. Using the same experimental arrangements the external bremsstrahlung emitted when the P^{32} β-rays are completely stopped in carbon, aluminium, iron, tin, and lead was also measured. For light elements the observed spectrum was found to agree closely with the theory by Bethe and Heitler as improved by Elwert, but for heavy elements and high energies to exceed the calculated values considerably, e.g. for lead at 500 and 1000 keV by a factor of 1·4 and 2·0 respectively. A.

539.165.8

3069. Internal and external bremsstrahlung in connection with the beta decay of S^{35}. N. STARFELT AND N. L. SVANTESSON. *Phys. Rev.*, **97**, *No.* 3, 708–14 (*Feb.* 1, 1955).

The internal bremsstrahlung, emitted in the β-decay of S^{35}, was investigated with a NaI scintillation spectrometer. Neither the shape of the spectral distribution nor the absolute yield was found to agree with theory. At 50 keV the experimental photon yield was 65% greater than the theoretical. At 100 keV it was even 180% greater. The total photon energy yield per β-decay, $2{\cdot}23\times10^{-5}$ mc^2, was 35% greater than the calculated value. The external bremsstrahlung, emitted when the β-particles from S^{35} were stopped in matter, was also investigated with the same apparatus. With elements of low atomic number the experimental values agreed with those calculated. In experiments using elements of higher atomic numbers, however, the experimental values differed widely from those calculated, the difference increasing with the atomic number. Thus, for lead at 50 keV the experimental value was 60% greater than the theoretical, and at 100 keV it was 170% greater. A.

539.166

3070. The harmonic mean energy for photon absorption by nuclei. J. GOLDEMBERG AND J. LEITE LOPES. Letter in *Nuovo Cimento*, **12**, *No.* 5, 817–18 (*Nov.*, 1954).

Using the relation given by Levinger and Bethe between the harmonic mean energy W_H and the expectation value of the squared displacement of a nucleon in the nuclear ground state, $\langle r^2\rangle_{00}$, experimental results for the absorption are analysed. These show that $\langle r^2\rangle_{00}$ does not increase with A and is of the order of magnitude expected for the mean square displacement of a nucleon inside an α-particle $3{\cdot}5\times10^{-26}$ cm^2. G. E. BROWN

539.166

3071. A study of the γ-radiation emitted by different sources of P^{32}. M. LANGEVIN, T. YUASA AND J. MÉRINIS. Letter in *J. Phys. Radium*, **15**, *No.* 11, 778–9 (*Nov.*, 1954) In French.

The γ-radiation was observed under conditions which minimized external bremsstrahlung from the source support. About 95% of the γ-radiation detected using a scintillation spectrometer was internal bremsstrahlung from P^{32}, and the spectrum agrees with the theoretical shape of Knipp and Uhlenbeck up to 1·6 MeV. A weak line at 720 keV in two sources may be due to P^{33}. A line at 565 keV noted by Goodrich *et al.* [Abstr. 740 (1954)] is attributed to traces of As^{76}. A. O. STANESBY

539.166

3072. On the conversion-electron spectra of the elements Ba^{137} and Ba^{134}. J. VERHAEGHE AND J. DEMUYNCK. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 21, 1374–6 (*Nov.* 22, 1954) In French.

These were studied in a double-focusing β-spectrometer of relatively high (500) resolving power. The 661 keV γ-ray of Ba^{137} is probably a mixture of *M*4 and *E*5 transitions. For Ba^{134}, 12 γ-rays were found and are tabulated. A. O. STANESBY

539.166

3073. The angular distribution of the gamma-rays from the reaction $C^{12}(p,\gamma p')C^{12}$. S. A. HEIBERG, D. B. JAMES AND T. K. ALEXANDER. Letter in *Canad. J. Phys.*, **33**, *No.* 1, 34 (*Jan.*, 1955).

The angular distribution of the low-energy γ-radiation [see Abstr. 6864 (1954)] can be represented by $0{\cdot}02 \pm 0{\cdot}02 + \sin^2\theta$ at bombarding energies of 1·37 and 1·58 MeV, and confirms the direct radiative capture mechanism. M. A. GRACE

539.166

3074. Measurements of spectral and angular distributions of secondary gamma-rays in matter. G. N. WHYTE. *Canad. J. Phys.*, **33**, *No.* 2, 96–109 (*Feb.*, 1955).

The distribution in energy and angle of the secondary γ-radiation emerging from the face of a concrete barrier containing a point source of cobalt-60 has been measured as a function of barrier thickness. Results on energy spectra and angular distributions are presented, and some of their features are compared with theoretical predictions. The operation of the two-crystal spectrometer and the photographic system for recording pulse-height distributions are described in some detail. A.

539.166

3075. Electromagnetic spectrum of Am^{241}. P. P. DAY. *Phys. Rev.*, **97**, *No.* 3, 689–700 (*Feb.* 1, 1955).

The electromagnetic spectrum of Am^{241} has been studied with a 10 in. bent-crystal spectrometer and a sodium iodide scintillation counter. Twelve γ-rays, 16 Np L X-rays and 8 Am L X-rays have been measured. The γ-rays in Np have energies of 26·363, 33·199, 43·463, 59·568, 103, 113, 130, 159, 210, 270, 328 and 370 keV. The X-ray energies establish the validity of the Mosley extrapolations in this region of the periodic table. Details of the spectrometer operation and calibration are given. A.

539.166 : 539.172.13

3076. High-energy gamma rays from the proton bombardment of fluorine. G. K. FARNEY, H. H. GIVIN, B. D. KERN AND T. M. HAHN. *Phys. Rev.*, **97**, *No.* 3, 720–5 (*Feb.* 1, 1955).

Resonances for emission of γ-rays of energy greater than 8 MeV in the reaction $F^{19}(p, \gamma)Ne^{20}$ have been measured for proton energies from 550 to 1450 keV using a thin target. Resonances were seen at 669, 874, 935, 980, 1090, 1280, 1320, 1355, 1380 and 1430 keV. The effect of false high-energy γ-ray counts resulting from the nearly simultaneous detection of two 6–7 MeV γ-rays in the reaction $F^{19}(p, \alpha\gamma)O^{16}$ was noted and a method for correcting for this effect was devised. The intensities of γ-rays for the two reactions were compared at each resonance. Also, the angular distribution of the 12 MeV γ-rays emitted at the 669 keV (p, γ) resonance was measured and found to be isotropic to within 2% probable error. A.

539.166.74

3077. Radiation damping in Compton scattering. T. C. ROY. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 524–9 (*Sept.–Oct.*, 1954).

Using the semi-variational procedure of Hsüeh and Ma [Abstr. 2683 (1945)] it is shown that the effect of damping is small even for high initial photon energies. See also Abstr. 1856 (1945) and *Proc. Camb. Phil. Soc.*, **37**, 301–16 (*July*, 1941).

G. E. BROWN

539.166.83

3078. Auger transitions in Bi^{212}(ThC). M. MLADJENOVIĆ AND H. SLÄTIS. *Ark. Fys.*, **9**, *Paper* 4, 41–7 (1954).

The energies and intensities of the Auger electrons in the β-spectrum of ThB + C + C′ have been studied by means of a semicircular permanent magnet β-ray spectrometer with photographic recording. The effective incremental charge ΔZ was calculated for different L-subshells. The values obtained were in excellent agreement with the ΔZ values for double ionized mercury measured by Bergström and Hill. The intensities of the Auger lines were compared with measurements of other authors as well as with theoretical calculations by Massey and Burhop. The fluorescence yield for the K-shell was found to be 0·96. A.

539.166.835

3079. Angular correlation of the electrons of pairs from the 3·09 MeV γ-radiation of carbon 13. Measurement of the multipolarity of this radiation. S. GORODETZKY, R. ARMBRUSTER, P. CHEVALLIER AND A. GALLMAN. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1623–5 (*Dec.* 8, 1954) In French.

C^{13} was produced in its first excited state by the $C^{12}(d, p)$ reaction, using 1·2 MeV deuterons. The observed angular correlation of the internal electron pairs confirms that the transition is $E1$. J. J. WILKINS

539.166.835

3080. Nature of positron annihilation in liquids and solids. W. R. DIXON AND L. E. H. TRAINOR. *Phys. Rev.*, **97**, *No.* 3, 733–6 (*Feb.* 1, 1955).

An interpretation of the experimental results on positrons stopping in liquid and solid media is presented in terms of annihilation from excited states of positronium. It is assumed on an empirical basis that the $2S$ states of positronium have sufficient stability in certain materials for direct annihilation. A.

539.167.3

3081. Enrichment of recoil atoms in sparingly soluble solid compounds. W. BUSER, P. GRAF AND U. IMOBERSTEG. *Z. Elektrochem.*, **58**, *No.* 8, 605–9 (1954) In German.

The impulse the absorbing atoms receive during (n, γ) processes is sufficient to eject them, even in solid compounds, from their positions in the lattice. In the case of sparingly soluble compounds possessing disordered lattice regions beside a well-ordered main lattice, a more or less pronounced enrichment in recoil atoms takes place in the disordered lattice; these recoil atoms can be obtained in the solution form through appropriate exchange reactions. Good yields of carrier-free isotope preparations can be obtained by this method which ensues from the Szilard–Chalmers methods. Data are given relating to the enrichment of Mn^{56}, Co^{60} and Zn^{65}.

F. LACHMAN

539.167.3

3082. Ultimate disposal of radioactive wastes. W. S. GINELL, J. J. MARTIN AND L. P. HATCH. *Nucleonics*, **12**, *No.* 12, 14–18 (*Dec.*, 1954).

Investigations of the absorption of radioactive cations in a montmorillonite clay, using Sr^{90}, Y^{91}, Zr^{95}, Cs^{139}, Ce^{144}, Pm^{147} and mixed fission products as tracers, are described. The exchanged active cations are fixed in the crystal lattice by heating at 900°C or more. After heat treatment, leaching by sea water, or other suitable replacement solution, removes only a very small proportion of the activity from the clay. L. R. SHEPHERD

NUCLEAR REACTIONS 539.17

539.17 : 530.145

3083. Nuclear reactions between charged particles. M. MOSHINSKY. *Rev. Mexicana Fis.*, **2**, *No.* 4, 244–67 (*Oct.*, 1953) In Spanish.

The formalism for the description of resonance reactions in Fock space, developed previously by the author for particles without Coulomb interaction [Abstr. 4688 (1951)] is generalized to charged particles. In particular the distribution of poles of the S-matrix

for the reaction, is shown not to be affected by the presence of the long-range electrostatic interaction. For low energies the phase shifts can be expressed in terms of the scattering length and effective range, as in the analysis of Bethe and Teichmann. The effect of the Coulomb barrier on the width of the resonance levels is also discussed. A.

539.172 : 523.877

3084. The neutrino and the formation of technetium in certain stars. M. E. NAHMIAS. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1595–7 (*Dec.* 8, 1954) In French.

The closed cycle $Ru^{99} + \nu = Tc^{99} + \beta^+$, $Tc^{99} = Ru^{99} + \beta^- + \nu$ is proposed in order to avoid difficulties arising from the terrestrial and meteoric rarity of Tc. R. A. NEWING

539.172 : 778.34

Calculation of the number of events in a given volume of nuclear emulsion. *See Abstr.* 3380

539.172

Nuclear reactions due to cosmic rays. *See also under* "Cosmic rays." Decimal classification 537.591.8

539.172

3085. π^--p interactions at 1·4 BeV. L. M. EISBERG, W. B. FOWLER, R. M. LEA, W. D. SHEPHARD, R. P. SHUTT, A. M. THORNDIKE AND W. L. WHITTEMORE. *Phys. Rev.*, **97**, *No.* 3, 797–808 (*Feb.* 1, 1955).

π^--p interactions have been observed in the hydrogen filling of diffusion cloud chambers exposed to a π^- beam of average energy 1·37 BeV at the Brookhaven Cosmotron. If 9 interactions leading to heavy unstable particles are omitted, there remain 147 interactions observed with magnetic field and 323 interactions without field. The total cross-section is estimated to be $34·6 \pm 2·7$ millibarn. The elastic scattering cross-section is $10·0 \pm 0·8$ millibarn. The elastic scattering angles are mostly less than 60° in the centre-of-mass system and are accordingly interpreted as mainly due to diffraction scattering. The observations are consistent with diffraction by a sphere with radius $(1·18 \pm 0·10) \times 10^{-13}$ cm and transparency $0·61 \pm 0·10$. However, the 20% of elastic scattering observed through angles $> 60°$ may indicate a region of very strong interaction with radius $\sim 0·5 \times 10^{-13}$ cm surrounded by a region of much weaker interaction. Of the inelastic events only the 95 observed in the magnet cloud chamber can be analysed further. Of these 71 to 81 are considered to involve the production of one secondary pion and 14 to 24 two pions, depending on the assignment of unidentified inelastic cases. This indicates a slightly greater multiplicity than predicted by Fermi's statistical theory. Angle and momentum distributions of emitted pions are discussed in terms of possible pion-pion interactions and excited nucleon states, but conclusions on these questions are uncertain. A.

539.172.1

3086. Angular distribution in the reaction (He^3, $2p$). M. DEMEUR. *Physica*, **20**, *No.* 12, 1189–99 (*Dec.*, 1954) In French.

The angular distributions of the particles emitted in (He^3, $2p$), (H^3, $2n$), (He^3, p,n) and (H^3, p,n) reactions have been calculated, supposing the occurrence of a stripping process and using Born approximation. A.

539.172.1

3087. Deuterium He^3 reaction. W. E. KUNZ. *Phys. Rev.*, **97**, *No.* 2, 456–62 (*Jan.* 15, 1955).

By the use of accelerated He^3 ions, the reaction $H^2(He^2, p)He^4$ has been studied in the energy range 100–800 keV (He^3 energy). The angular distribution of the protons was found to be isotropic at bombarding energies of 200, 290, and 350 keV. The reaction cross-section has a peak of 695 ± 14 millibarn as determined with reference to the peak value 5·00 barns for the comparison reaction, $H^3(H^2, n)He^4$. The comparison was effected by alternately bombarding the same deuterium target with tritium and He^3 ions, and counting the α-particles. The peak occurred at 640 keV He^3 ion bombarding energy. From considerations of the absolute value of the cross-section, it is concluded that the resonance at 640 keV is associated with a $J = \frac{3}{2}$ level in the compound nucleus. The experimental shape of the peak is well fitted by resonance parameters in the one-level dispersion formula having the following values: interaction radius R, 5×10^{-13} cm; reduced width for proton emission γ_p, 41·9 keV; reduced scattering width γ_α, 2930 keV; "formal" resonance energy in the centre-of-mass system ε_s, 391 keV; energy of the level above the ground state of Li^5: $16·2 \pm 0·3$ MeV. These values agree within experimental error with analogous values associated with the similar resonance which occurs in the $H^2(H^3, n)He^4$ reaction. A.

539.172.11

3088. Energy levels in Ca^{42} and Ca^{44}. J. P. SCHIFFER. *Phys. Rev.*, **97**, *No.* 2, 428–31 (*Jan.* 15, 1955).

The $K^{39}(\alpha,p)Ca^{42}$, $K^{41}(\alpha,p)Ca^{44}$, and $Ca^{43}(d,p)Ca^{44}$ reactions were studied and ground state Q-values of −0·19, 0·98, and 9·07 MeV respectively were found. Energy levels in Ca^{42} were found at 1·51, 1·95, 2·29, 2·59, and 3·02 MeV and in Ca^{44} at 1·13, 1·92, 2·28, 2·58, 2·97, and 3·17 MeV. An anomalously low cross-section was observed for the $Ca^{43}(d,p)Ca^{44}$ reaction. A.

539.172.11

3089. Elastic scattering of 22-MeV alpha particles. N. S. WALL, J. R. REES AND K. W. FORD. *Phys. Rev.*, **97**, *No.* 3, 726–32 (*Feb.* 1, 1955).

The elastic scattering of 22 MeV α-particles from silver, gold, and lead has been measured as a function of angle. The differential cross-section has been found to follow Rutherford's equation at forward angles but at some critical angle the cross-section deviates, first increasing slightly for lead and gold and then decreasing monotonically. The silver distribution shows no increase. The lead and gold data have been fitted with a modification of Blair's sharp angular momentum cut-off theory but there is no satisfactory agreement between theory and experiment for the silver data. Using this type of analysis one is able to find a nuclear radius that follows the $R = r_0 A^{\frac{1}{3}}$ law with $r_0 = 1·5 \times 10^{-13}$ cm only if one assumes a large size, $\sim 2·5 \times 10^{-13}$ cm, for the α-particle. A.

539.172.13 : 539.155.4 : 537.534.72

On heavy particle technique, its application to scattering mass analysis and to the $Al^{23}(d,\alpha)Mg^{25}$ and $Al^{27}(d,p)Al^{28}$ reactions. *See Abstr.* 2804

539.172.13 : 537.534.74

3090. Possible triple-scattering experiments. L. WOLFENSTEIN. *Phys. Rev.*, **96**, *No.* 6, 1654–8 (*Dec.* 15, 1954).

Triple-scattering experiments may be used to get additional information about the spin-dependence of the scattering matrix of the second scatterer. In general two new parameters describing the scattering may be determined by means of two distinct experiments, one in which the successive scattering planes are parallel and one in which the successive scattering planes are at right angles to each other. The relation between these parameters and the scattering matrix is given for the cases of protons scattered from a spin-zero target and of proton-proton scattering. For the former case the magnitude of the left-right asymmetry in the third scattering is calculated on the basis of a phenomenological model due to Fermi in the Born approximation. Further experimental possibilities for p–p scattering are discussed. A.

539.172.13

3091. The reaction ^{25}Mg $(p,\gamma)^{26}$Al. I. Experimental. J. C. KLUYVER, C. VAN DER LEUN AND P. M. ENDT. *Physica*, **20**, *No.* 12, 1287–98 (*Dec.*, 1954).

Energies and intensities have been measured of γ-rays produced at six resonances in the region $E_p = 0{\cdot}3 - 0{\cdot}7$ MeV. Thin enriched Mg^{25} targets were bombarded with protons from a Cockcroft–Walton generator, and γ-rays were detected with a scintillation spectrometer. The resulting pulse spectra were analysed with a differential discriminator and photographed on an oscilloscope screen. The resonances investigated could be assigned to Mg^{25} by comparison with runs on enriched Mg^{24} and Mg^{26} targets. The Mg^{25} resonances are found at 321, 395, 441, 501, 518, 580, 607, 667 and 688, all ± 15 keV. The 501 and 518 keV resonances could not be resolved completely, but they show almost identical γ-ray spectra. The resonances at 667 and 688 keV have not been investigated in detail. The six resonances investigated in detail show complicated γ-ray spectra, different from resonance to resonance. A list of γ-ray energies and intensities is given. From absolute γ-ray yield measurements the radiation widths of all resonances (multiplied by a statistical factor) could be determined. A.

539.172.13

3092. The reaction ^{25}Mg (p,γ) ^{26}Al. II. Conclusions. P. M. ENDT, J. C. KLUYVER AND C. VAN DER LEUN. *Physica*, **20**, *No.* 12, 1299–309 (*Dec.*, 1954).

The measurements described in Pt I are used to obtain the position, spin and isobaric spin of energy levels in Al^{26}. All the observed intensive high-energy γ-rays can be explained as transitions from resonance levels to the levels found by Browne from the $Si^{28}(d,\alpha)Al^{26}$ reaction and to one additional level at $E_x = 2{\cdot}57 \pm 0{\cdot}04$ MeV. The low-energy γ-rays fit the same level scheme, plus one more additional level at $E_x = 0{\cdot}235 \pm 0{\cdot}009$ MeV. The latter level is actually the first excited state in Al^{26}, which turns out to be an isomeric state decaying by β^+ emission with the long known half-life of 6·6 sec. Spins J, parities and isobaric spins T can be assigned as follows: $E_x = 0$ $(J = 5^+, T = 0)$, $E_x = 0{\cdot}235$ MeV $(J = 0^+, T = 1)$, $E_x = 0{\cdot}419$ MeV $(J = 3^+, T = 0)$, $E_x = 1{\cdot}055$ MeV $(J = 1^+, T = 0)$, $E_x = 1{\cdot}750$ MeV $(J = 2^+, T = 0)$, $E_x = 2{\cdot}064$ MeV $(J = 2^+, T = 0)$. The resonance level at $E_x = 6{\cdot}73$ MeV has $J = 4^-$, $T = 0$. Tentative assignments to the other resonance levels are discussed. The 6·6 sec β^+ decay is remarkable by being one of the few known $0^+ \rightarrow 0^+$ transitions. The β^+ endpoint can best be arrived at by using a cycle involving the 0·820 MeV γ-ray from $Mg^{25}(p,\gamma)Al^{26}$, the Q-value of the $Si^{28}(d,\alpha)Al^{26}$ transition to the 1·055 MeV level in Al^{26}, and a re-evaluation of the Si^{28}–Mg^{26} mass difference. This yields $E_{\beta+} = 3{\cdot}225 \pm 0{\cdot}015$ MeV, and $ft = 3200 \pm 80$ sec. The ft value of this β^+ transition can now be used for direct evaluation of the Fermi coupling constant g_F. The result is: $g_F = (1{\cdot}391 \pm 0{\cdot}017) \times 10^{-49}$ erg. cm^3. A.

539.172.13

3093. Levels of ^{24}Mg from the ^{27}Al (p,α) ^{24}Mg reaction. G. W. GREENLEES. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 12, 1107–8 (*Dec.*, 1954).

α-particle groups with Q-values of $1{\cdot}61 \pm 0{\cdot}04$, $0{\cdot}23 \pm 0{\cdot}03$ and $-2{\cdot}57 \pm 0{\cdot}04$ MeV have been measured using photographic emulsion recording and 6·5 MeV protons. These correspond to transitions to the ground state and low-lying excited states in Mg^{24} and have differential cross-sections of 0·16. 0·61 and 0·15 barn/steradian measured at 90°. M. A. GRACE

539.172.13 : 539.152.1

3094. New experimental evidence for the existence of instantaneous sub-structures in the light nuclei of photographic emulsion in interaction with energetic nucleons. P. CÜER, J. COMBE AND A. SAMMAN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 1, 75–7 (*Jan.* 3, 1955) In French.

Scattering of 340 MeV protons indicates an important fraction of elastic scattering on sub-structures in the light nuclei. p–α collisions are identified in many cases for C^{12}, and the results of Strauch and Titus [Abstr. 10268 (1954)] are quantitatively explained on this basis. P. T. MATTHEWS

539.172.13

3095. Proton-gamma resonances in magnesium. S. E. HUNT AND D. A. HANCOCK. Letter in *Phys. Rev.*, **97**, *No.* 2, 567–8 (*Jan.* 15, 1955).

By using separated isotope targets the following resonances have been identified:—

$Mg^{24}(p,\gamma)Al^{25}$	$225{\cdot}5 \pm 0{\cdot}2$ and $418{\cdot}4 \pm 0{\cdot}5$ keV.
$Mg^{25}(p,\gamma)Al^{26}$	$316{\cdot}7 \pm 0{\cdot}7$, $391{\cdot}5 \pm 0{\cdot}5$, $436{\cdot}5 \pm 0{\cdot}4$, $495{\cdot}6 \pm 0{\cdot}6$, $513{\cdot}4 \pm 0{\cdot}7$ and $530{\cdot}4 \pm 0{\cdot}7$ keV.
$Mg^{26}(p,\gamma)Al^{27}$	$338{\cdot}5 \pm 0{\cdot}5$ and $454{\cdot}2 \pm 0{\cdot}3$ keV.

Positron activity of 6·7 second half-life was observed from both the $Mg^{24}(p,\gamma)Al^{25}$ resonances and from all the $Mg^{25}(p,\gamma)Al^{26}$ resonances except that of $436{\cdot}5 \pm 0{\cdot}4$ keV. These results indicate that the state in Al^{26} producing the 6·7 second β^+-activity is not the $J = {}^+$ ground state but an excited state with $J = 0^+$. D. R. CHICK

539.172.13

3096. Excitation functions for the scattering of protons and deuterons by Be and Mg. G. W. GREENLEES. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2. 97–103 (*Feb.*, 1955).

Absolute differential cross-sections are given for the elastic and inelastic scattering by Mg of protons with energies between 3·0 and 6·5 MeV and of deuterons with energies between 4·0 and 7·8 MeV. These were taken at an angle of 70° in the laboratory co-ordinates. Similar cross-sections are given for protons scattered elastically and inelastically by beryllium at 90°. The levels giving rise to inelastic scattering have Q values of $-1{\cdot}37 \pm 0{\cdot}04$ MeV and $-2{\cdot}43 \pm 0{\cdot}05$ MeV for magnesium and beryllium respectively. The marked difference of excitation function for protons and deuterons is noted and a discussion of possible mechanisms involved is given. A.

539.172.13

3097. Tritium and neutron production by 2·2-BeV protons on nitrogen and oxygen. E. L. FIREMAN AND F. S. ROWLAND. *Phys. Rev.*, **97**, *No.* 3, 780–2 (*Feb.* 1, 1955).

The cross-sections for tritium production by 2·2 BeV protons on nitrogen and oxygen are measured to be 28 ± 4 and 33 ± 4 mb, respectively. The cross-sections for neutron production by 2·2 BeV protons are measured to be 1000 ± 400 mb for nitrogen and 650 ± 250 mb for oxygen. These results indicate that cosmic-ray primaries produce approximately 0·05 tritons/cm² sec and 1–2 neutrons/cm² sec in the first nuclear interaction with the atmosphere. A.

539.172.13 : 539.172.4

3098. Total cross-sections for nuclear scattering. K. M. GATHA AND G. Z. SHAH. Letter in *Curr. Sci.*, **23**, *No.* 11, 355–6 (*Nov.*, 1954).

Using the optical model and a Gaussian nuclear density distribution, with the parameters of a previous analysis of 340 MeV scattering [Abstr. 11317 (1954)], calculations have been made of total cross-sections for 400 MeV neutrons and 315 MeV protons on several elements. Reasonable agreement with experiment is obtained. P. T. MATTHEWS

539.172.13

3099. Comparison of H^3 and He^3 production in high-energy deuteron-deuteron collisions. C. S. GODFREY. *Phys. Rev.*, **96**, *No.* 6, 1621–7 (*Dec.* 15, 1954).

The relative production of H^3 and He^3 from deuteron-deuteron collisions at 190 MeV has been measured at 30° (centre of mass). The method of detection required that the particles traverse a magnetic channel and a pulse-height counter telescope. The pulses were displayed on a fast cathode-ray oscilloscope and recorded photographically. A liquid deuterium target was employed. The comparison shows a ratio of H^3 to He^3 of $0{\cdot}86 \pm 0{\cdot}14$. These data support the hypothesis that charge symmetry of nuclear forces exists at high energy. A.

539.172.13

3100. Angular correlation in the reaction $^{14}N(d, \alpha\gamma\gamma)^{12}C$. J. SEED. Letter in *Phil. Mag.*, **46**, 100–2 (*Jan.*, 1955).

The correlation between 3 MeV and 4·5 MeV γ-rays has been measured. The results are consistent with zero spin, even parity for the 7·5 MeV level of C^{12}. J. J. WILKINS

539.172.13

3101. Excitation function for Na^{22} from deuterons on aluminum. S. O. RING AND L. M. LITZ. *Phys. Rev.*, **97**, *No.* 2, 427–8 (*Jan.* 15, 1955).

The cross-section for the reaction $Al^{27}(d, d\alpha n)Na^{22}$ has been determined as a function of deuteron energy in the energy range from 30 to 190 MeV. This reaction may be used for monitoring a high-energy deuteron beam. A.

539.172.13

3102. Tritium production from lithium by deuteron bombardment. R. L. MACKLIN AND H. E. BANTA. *Phys. Rev.*, **97**, *No.* 3, 753–7 (*Feb.* 1, 1955).

The tritium production cross-section has been measured for Li^6 bombarded by deuterons from 0·4 MeV to 4·0 MeV. The cross-section rises fairly rapidly to 190 millibarns near 1 MeV, then more slowly to 290 millibarns near 4 MeV. The cross-section for Li^7 rises steeply from the 1·27 MeV threshold to 95 millibarns at 2·4 MeV; then more slowly to about 165 millibarns at 4·1 MeV. A.

539.172.3

3103. A study of the photodisintegration of C^{12} into three alpha-particles. A. M. GUREWITSCH. *Dissert. E.T.H. Zürich, Paper* 2205, 75 *pp.* (1953).

Nuclear emulsions exposed to 100 MeV betatron radiation were used to study this reaction, particularly above 20 MeV. The major results reported are a (second) maximum, $\sim 2{\cdot}5 \times 10^{-28}$ cm², in the cross-section at about 27 MeV γ-ray energy and evidence for a level in Be^8 at about 17 MeV excitation. J. J. WILKINS

539.172.3

3104. An investigation of the (γ, n) reaction in Cu, Zn, and Ag. D. ST. P. BUNBURY. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 12, 1106–7 (*Dec.*, 1954).

(γ, n) yields were measured over ± 65 keV range of γ-ray energies near 17·6 MeV, using $Li^7(p, \gamma)$ radiation. Some evidence of fine structure in the yield curves was obtained. J. J. WILKINS

539.172.3

3105. The absolute standardization of the 2·615 MeV γ-rays of ThC″ and the cross-section for the photo disintegration of the deuteron at this energy. P. MARIN, G. R. BISHOP AND H. HALBAN. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, *Pt* 12, 1113 (*Dec.*, 1954).

Correction of an error in previous work [Abstr. 7140 (1953)] gives the revised results: mg radium equivalent of ThC″, $0{\cdot}407 \pm 0{\cdot}007$ mc; photodisintegration cross-section of the deuteron $(13{\cdot}0 \pm 0{\cdot}29) \times 10^{-28}$ cm². J. J. WILKINS

539.172.3

3106. Experiments on the direct photonuclear effect. S. A. E. JOHANSSON. *Phys. Rev.*, **97**, *No.* 2, 434–43 (*Jan.* 15, 1955).

An investigation has been made of the high-energy protons and neutrons emitted in irradiation with bremsstrahlung of 65 MeV maximum energy. Protons above 14 MeV were measured. The energy limit for

the neutrons varied. The angular distributions of protons from carbon, aluminium, nickel and molybdenum could be fitted with curves of the form $a + (\sin\theta + b\sin\theta\cos\theta)^2$ with the maximum around 60°. The angular distributions of neutrons above 5 and 10 MeV could be fitted with curves of the form $a + b\sin^2\theta$. The yield of protons for eight elements from carbon to molybdenum was approximately proportional to Z. The yield of neutrons above 7·5 MeV for 19 elements from carbon to lead was approximately proportional to N. Excitation curves were measured for the high-energy protons from aluminium and phosphorus. They have a threshold at about 25 MeV and rise to about 45 MeV. From there on they are nearly constant. An attempt was made to detect proton-neutron coincidences from a carbon target. No true coincidences were found. It is concluded that the measurements are in good agreement with an independent particle model but that they agree only partly with a deuteron model. A.

539.172.3

3107. Effects of isotopic spin selection rules on photonuclear yields. H. MORINAGA. *Phys. Rev.*, **97**, *No.* 2, 444–6 (*Jan.* 15, 1955).

The effects of isotopic spin selection rules were taken into consideration in order to explain the observed high ratio of (γ, p) to (γ, n) cross-sections. The recent experimental evidence on the separate giant resonances for (γ, p) and (γ, n) cross-sections seems to support this viewpoint. A.

539.172.3

3108. The $^{12}C(\gamma, 3\alpha)$ reaction and energy levels of ^{8}Be and ^{12}C. F. K. GOWARD AND J. J. WILKINS. *Proc. Roy. Soc. A*, **228**, 376–96 (*March* 8, 1955).

The mechanism for γ-ray energies, E_γ, up to about 40 MeV has been determined from a study of over 2500 stars in nuclear emulsions. The study includes investigation of the angular distributions and correlations of the α-particles. The reaction is initiated mainly by electric-dipole and electric-quadrupole γ-ray interaction, the former being unexpectedly strong when $E_\gamma < 20$ MeV. For $E_\gamma < 25$ MeV the reaction proceeds mainly by transitions to the ground-state of Be^8 (spin $J = 0$), and to $2{\cdot}95 \pm 0{\cdot}10$ MeV ($J = 2$) and $4{\cdot}0 \pm 0{\cdot}1$ MeV ($J = 2$ or 4) levels of Be^8. Transitions to levels near 6, 10 and 15 MeV (all $J = 0$, 2 or 4) become predominant when 25 MeV $\leqslant E_\gamma < 26$ MeV. For $E_\gamma \geqslant 26$ MeV, most transitions lead to $16{\cdot}8 \pm 0{\cdot}2$ MeV ($J = 2$) and $17{\cdot}6 \pm 0{\cdot}2$ MeV ($J = 2$, possibly 0) levels, and possibly to a further $16{\cdot}4 \pm 0{\cdot}2$ MeV ($J = 0$ or 2) level, levels which have not been detected in other reactions. The reaction mechanism is interpreted in terms of competing modes of decay of a compound nucleus, demonstrating the strong influence of the isotopic spins (T) of the levels of C^{12} and Be^8 involved. For example, the 2^+ levels of C^{12} involved when 16 MeV $\leqslant E_\gamma < 20$ MeV are (unexpectedly) found to have $T = 1$, and the 16·8 and 17·6 MeV levels of Be^8 are also found to have $T = 1$. The relationship of the $C^{12}(\gamma, 3\alpha)$ reaction to other C^{12} photodisintegration reactions (including some new reactions established during the present experiments) is discussed. A.

539.172.4

3109. Tables for simplifying calculations of activities produced by thermal neutrons. F. E. SENFTLE AND W. R. CHAMPION. *Nuovo Cimento Suppl.*, **12**, *No.* 3, 549–71 (1954).

See Abstr. 7503 (1950). These tables have been revised and recompiled to include new nuclear data.

539.172.4

3110. Scattering of neutrons by nitrogen N^{14}. D. SPEISER. *Helv. phys. Acta*, **27**, *No.* 5, 427–40 (1954) In German.

Experimental results for the energy region 2·6–4·18 MeV are analysed. A generalized Breit–Wigner model is adopted in which it is assumed that one level is responsible for the scattering in each energy range; j and parity are tentatively assigned to each level. G. E. BROWN

539.172.4

3111. Analysis of scattering phases for elastic n–C^{12} scattering between 1·9 and 3·8 MeV. P. HUBER AND R. BUDDE. *Helv. phys. Acta*, **27**, *No.* 6, 512–14 (1954) In German.

The elimination of experimental uncertainties in previous work (P. Huber *et al.*, 1952) leads to differential cross-sections which, when combined with recent total cross-section and polarization measurements [Abstr. 8705 (1953)] give curves for $S_{1/2}$, $P_{1/2, 3/2}$, $D_{3/2}$ phases between 1·9 and 3·8 MeV. There are $D_{3/2}$ resonances at 2·08, 2·95, 3·62 MeV. W. J. SWIATECKI

539.172.4

3112. Remark on the angular distribution in the reaction (n, p). M. DEMEUR. Letter in *J. Phys. Radium*, **16**, *No.* 1, 73–4 (*Jan.*, 1955) In French.

Using the stripping theory approximations of Bhatia *et al.* [Abstr. 6756 (1952)] it is possible to obtain the results of Austern, Butler and McManus [Abstr. 1729 (1954)] and to extend the results to the interactions $(d, 2n)$ and (H^3, He^3). G. E. BROWN

539.172.4

3113. Scattering of 14·3 MeV neutrons by ^4He nuclei. D. F. SHAW. Note in *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 1, 43–5 (*Jan.*, 1955).

The differential cross-section was measured with a low pressure, helium-filled expansion cloud chamber, in the angular range 20°–90° c. of m. A graph is given comparing the results with those of Seagrave [Abstr. 1736 (1954)] and the theoretical predictions of Dodder and Gammel [Abstr. 1689 (1953)]. The theoretical curve gives the better fit. J. HUGHES

539.172.4

3114. The slow neutron cross section of scandium. N. J. PATTENDEN. *Proc. Phys. Soc.* [*London*] *A*, **68**, *Pt* 2, 104–9 (*Feb.*, 1955).

The neutron total cross-section of scandium oxide has been measured from 0·0015 eV to 5000 eV. A resonance in scandium was observed at (3600 ± 200) eV, with $\Gamma \sim 180$ eV, and at lower energies the cross-section varied in a way which could be explained by the existence of a level with parameters $E_r = -(130 \pm 30)$ eV, $\Gamma_n^0 = (0{\cdot}84 \pm 0{\cdot}25)$ eV and $\Gamma_a = (0{\cdot}25 \pm 0{\cdot}1)$ eV. A.

539.172.4

3115. Recoil deuterons and disintegration protons from the *n–d* interaction, and *n–p* scattering at $E_n = 14{\cdot}1$ MeV. J. D. SEAGRAVE. *Phys. Rev.*, **97**, *No.* 3, 757–65 (*Feb.* 1, 1955).

A counter-telescope consisting of two proportional counters and a NaI scintillator in triple coincidence has been used to study the angular distribution of scattered deuterons and disintegration protons from the interaction of 14·1 MeV neutrons with deuterium. Charged reaction products were identified by simultaneous observation of particle energy and rate of energy loss. Thin radiators of deuterated and normal polyethylene were used, the latter to investigate the incident neutron spectrum and *n–p* scattering at 14·1 MeV. The absolute differential cross-sections observed over the recoil angular range 0 to 55° in the laboratory for elastic *n–d* and *n–p* scattering are in good agreement with the recent nuclear-emulsion results of Allred, Armstrong, and Rosen, and with the theoretical results of Christian and Gammel. The anisotropy of *n–p* scattering was found to be about 6%. Protons from disintegration of deuterium were observed over the angular range of 0 to 80° in the laboratory, and the integrated cross-section for the forward hemisphere is larger than has been observed previously. The energy distributions appear more nearly uniform than those estimated by Frank and Gammel, and the angular distribution more strongly peaked forward. A.

539.172.4

3116. On some strontium isotopes in uranium fission. G. HERRMANN. *Z. Elektrochem.*, **58**, *No.* 8, 626–9 (1954) In German.

A careful analysis of the decay of Sr isotopes formed in thermal neutron fission using a method which eliminates errors due to the accumulation of daughter substances. An irregularity in the decay curve of Sr^{89}, whose ½-life was determined as $50{\cdot}4 \pm 0{\cdot}5$ days, is suggested as evidence for a Sr^{89} isomer. W. J. SWIATECKI

539.172.4

3117. Average number of neutrons emitted during the spontaneous fission of Cf^{252}. W. W. T. CRANE, G. H. HIGGINS AND S. G. THOMPSON. Letter in *Phys. Rev.*, **97**, *No.* 1, 242 (*Jan.* 1, 1955).

$3{\cdot}10 \pm 0{\cdot}15$ neutrons per spontaneous fission were found by activation of a manganese solution. Negligible contribution to this by neutrons from (α, n) reactions is expected owing to the low intensity of α-particles from Cf^{252}. M. A. GRACE

539.172.4

3118. Short-period delayed neutrons from fission. P. J. BENDT AND F. R. SCOTT. *Phys. Rev.*, **97**, *No.* 3, 744–9 (*Feb.* 1, 1955).

A new group of delayed neutrons having a mean life of 216 ± 60 milliseconds has been observed to follow fission of U^{235}. The apparent yield is $2{\cdot}7 \pm 0{\cdot}7\%$ of the delayed neutrons. The experiment was done using a multiplying assembly of uranium metal bombarded once every 30 seconds by X-rays from a betatron. A discussion is given of the hypothesis that these delayed neutrons follow the decay of Li^9, and that Li^9 is formed as the light fragment in ternary fission. A.

539.172.4 : 533.15

Diffusion of rare-gas fission products in uranium. *See Abstr.* 3123

539.172.4 : 539.152.1

3119. On the fission asymmetry and the "spatial" conception of nuclear shells. D. CURIE. *J. Phys. Radium*, **15**, *No.* 11, 733–42 (*Nov.*, 1954) In French.

An attempt to account for the asymmetry on the basis of a model in which the division occurs through the peeling off of a membrane surrounding a doubly magic core of 50 protons and 82 neutrons.

W. J. SWIATECKI

539.172.4

3120. Theory of homogeneous nuclear reactors. I. Effect of the neutron spectrum on the stationary conditions of a reactor. A. MEDINA. *Rev. Mexicana Fis.*, **2**, *No.* 1, 1–44 (*Jan.*, 1953) In Spanish.

The ordinary diffusional approach for homogeneous reactors is first completed, considering the spectra of fast neutrons produced in fission and the fast fission effect. This results in integro-differential diffusion equations, which are solved. The theory leads to a distinction between fast, intermediate and slow reactors. Diffusion theory equations are not, of course, expected to represent the actual behaviour of a fast pile, but the method illustrates the steps to be taken when transport theory is used. A.

539.172.4

3121. Theory of homogeneous nuclear reactors. II. Effect of the neutron spectrum on the dynamic conditions of a reactor. A. MEDINA. *Rev. Mexicana Fis.*, **2**, *No.* 2, 79–116 (*April*, 1953) In Spanish.

The diffusional approximation leads to integro-differential equations that can be solved by taking Laplace transforms. An equation results, describing the conditions of thermal and intermediate piles when the Fredholm determinant of the original equations does not vanish. A fast pile appears as a special case when the determinant vanishes, corresponding to the absence of an equilibrium thermal neutron density in the pile. A.

539.172.4

3122. Producing plutonium in U–D_2O reactors. M. BOGAARDT AND M. BUSTRAAN. *Nucleonics*, **12**, *No.* 12, 32–5 (*Dec.*, 1954).

The depletion of U^{235} and the growth of Pu^{239} and Sm^{149} poison, with operating time, are calculated for the case of a reactor having a constant average flux of 10^{14} $n/cm^2.sec$ and assuming a constant number of U^{238} atoms present. Three different initial conversion factors are assumed in the calculations. The change in reactivity with time is also determined. Bare and reflected spherical reactors are considered and the effect of moderate enrichment discussed.

L. R. SHEPHERD

539.172.4 : 533.15

3123. Diffusion of rare-gas fission products in uranium. K. E. ZIMEN AND P. SCHMELING. *Z. Elektrochem.*, **58**, *No.* 8, 599–601 (1954) In German.

Irradiation of U by neutrons leads to the production of a series of Kr and Xe isotopes as fission products. The diffusion of these rare-gas atoms, which is of

interest in the control of nuclear reactors, is considered and detailed results given concerning Xe^{133}.

J. THEWLIS

539.172.4 : 537.542

Measurement of neutron distribution within a pile. *See Abstr.* 2817

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

3124. The absorption of π-mesons by heavy nuclei. K. BLEULER AND C. TERREAUX. *Helv. phys. Acta*, **27**, *No.* 6, 489–91 (1954) In German.

It is suggested that the cross-section σ for this process can be understood if it is assumed that usually two nucleons are involved in the absorption. The energy-dependence of σ seems to require a derivative-coupling for the meson field.

W. J. SWIATECKI

539.18

3125. Landau distribution and density effect at high gas pressures. E. D. PALMATIER, J. T. MEERS AND C. M. ASKEY. *Phys. Rev.*, **97**, *No.* 2, 486–91 (*Jan.* 15, 1955).

Studies of the ionization energy losses of fast μ-mesons have been carried out in a specially constructed proportional counter with argon gas at pressures up to 40 atmospheres. With increasing pressure, a strong reduction in the relativistic rise was observed; the extent of the reduction being at least as great as that expected from Sternheimer's calculation of the density effect. Furthermore, the distribution in energy losses, which at low pressures is much wider than expected from theoretical considerations, was observed to become narrower with increasing pressure. At the highest pressure, however, the energy loss distribution was still considerably wider than predicted by the Landau theory.

A.

539.18

3126. Effect of the Pauli moment on the γ-decay of neutral meson. H. KATSUMORI. Letter in *Progr. theor. Phys.*, **12**, *No.* 2, 241–3 (*Aug.*, 1954).

A qualitative attempt is made to remove the discrepancy between experimental and theoretical values of the lifetime for the γ-decay of a neutral meson by introducing the Pauli moment phenomenologically. Pseudoscalar theory with pseudoscalar coupling is assumed.

G. FIELD

539.18

3127. Λ^0 excited state. D. C. PEASLEE. Letter in *Nuovo Cimento*, **12**, *No.* 6, 943–4 (*Dec.*, 1954).

Discusses the changed hyperon decay schemes $Y^{\pm} \rightarrow \pi^{\pm} + n + Q_2$; $Y^{+} \rightarrow \pi^{0} + p + Q_2$; $Q_2 \simeq 120$ MeV. It is suggested that these schemes can best be incorporated into the general scheme of V-particle decays by taking the $Y^{\pm}$ particle to be an excited state of the Λ^0 particle.

P. ROTHWELL

539.18

3128. A negative hyperon decaying in flight. A. DEBENEDETTI, C. M. GARELLI, L. TALLONE AND M. VIGONE. Letter in *Nuovo Cimento*, **12**, *No.* 6, 952–3 (*Dec.*, 1954).

The negative hyperon is emitted from a star observed in nuclear emulsion and after travelling 927 μ decays giving rise to a charged secondary which travels 16590 μ and then comes to rest producing a σ star. The suggested decay scheme for the hyperon is $Y^{-} \rightarrow n + \pi^{-} + (107 \pm 15)$ MeV.

H. ELLIOT

539.18

3129. Orientation of planes in double V^0 decay events. J. BALLAM, A. L. HODSON, W. MARTIN, R. R. RAU, G. T. REYNOLDS AND S. B. TREIMAN. Letter in *Phys. Rev.*, **97**, *No.* 1, 245–6 (*Jan.* 1, 1955).

Ten cloud chamber events [7 by Hodson *et al.* (1954)] can be interpreted as V^0 pair production, and an analysis seems to indicate a correlation expected on the basis of the following abstract for particles with spin $> \frac{1}{2}$.

W. J. SWIATECKI

539.18

3130. Angular correlation effects in unstable particle decay. S. B. TREIMAN, G. T. REYNOLDS AND A. L. HODSON. Letter in *Phys. Rev.*, **97**, *No.* 1, 244–5 (*Jan.* 1, 1955).

Using the methods of Wolfenstein (1949) a formula is derived for the angular correlation between the 2-body decay products of a spin-S particle. A lower limit on S can be obtained from the largest harmonic necessary to fit such correlation data (see preceding abstract).

W. J. SWIATECKI

539.18

3131. Radiative corrections to muon decay. R. J. FINKELSTEIN AND R. E. BEHRENDS. Letter in *Phys. Rev.*, **97**, *No.* 2, 568–70 (*Jan.* 15, 1955).

Radiative corrections of order e^2 to muon decay are calculated for the interactions $S + aP$, $S + aT + bP$, $S + aA + bP$, $a = \pm 1$, $b = \pm 1$. Unrenormalizable effects are cut off at the proton Compton wavelength. Corrections of about 3% are found for the lifetime, but no appreciable distortion of the spectrum.

P. T. MATTHEWS

539.18

3132. An estimate of the mean lifetime of the θ^0-particles. D. I. PAGE. Letter in *Phil. Mag.*, **46**, 103 (*Jan.*, 1955).

The mean lifetime estimated from 14 events is $(0{\cdot}7^{+0{\cdot}3}_{-0{\cdot}2}) \times 10^{-10}$ sec. Combining this value with all previously published results leads to a weighted mean value of $(1{\cdot}5^{+0{\cdot}4}_{-0{\cdot}3}) \times 10^{-10}$ sec.

H. ELLIOT

539.18 : 537.591.1

Mu-meson rest lifetime and variation of lifetime with momentum. *See Abstr.* 2839

539.18

3133. Search for electromagnetic interactions between μ mesons and electrons. L. S. OSBORNE, W. D. RANKIN, P. C. STEIN, A. WATTENBERG AND A. WINSTON. *Phys. Rev.*, **97**, *No.* 3, 809–10 (*Feb.* 1, 1955).

An attempt was made to observe the reaction $\gamma \rightarrow \mu^{\pm} + e^{\mp}$ up to 23 MeV above threshold. It was found that the cross-section for this reaction is less than 10^{-31} cm^2 per proton. The decay $\mu^{\pm} \rightarrow e^{\pm} + \gamma$ was also looked for, and its lifetime found to be longer than 10^{-3} second.

A.

539.18

3134. Observations on negative *K*-mesons. M. W. Friedlander, D. Keefe, M. G. K. Menon, R. H. W. Johnston, C. O'Ceallaigh and A. Kernan. *Phil. Mag.*, **46**, 144–9 (*Feb.*, 1955).

Three examples of negative heavy mesons which produce nuclear disintegrations at the end of their ranges in emulsion are described. Certain characteristics of the parent and capture stars of these mesons are discussed. A.

539.18 : 778.34

3135. A note on mass estimation by the range-scattering method. N. Norlind. *Ark. Fys.*, **8**, *Paper* 13, 155–60 (1954).

The smallest errors to be expected in the mass determination by the range-scattering method are derived. With a noise level of $0{\cdot}10\,\mu$ these errors are for the ranges $R = 5000\,\mu$ and $10\,000\,\mu$ 20% and 14% respectively. The effect of using a variable cell-length is found to be small. A.

539.18

3136. The mass of a π^- meson determined from a σ-star. W. F. Fry and J. Schneps. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 1, 272–3 (*Jan.*, 1955).

The π^--meson is absorbed by an O^{16} nucleus producing a β-emitting recoil C^{15} and a proton. The mass of the π^--meson, deduced from the visible energy release and the appropriate binding energies, is $283 \pm 16\ m_e$. H. ELLIOT

539.18

3137. Production of π-mesons by photons and nucleon isobars. V. I. Ritus. *Zh. éksper. teor. Fiz.*, **27**, *No.* 6 (12) 660–76 (1954) In Russian.

A nucleon isobar state of both ordinary and isotopic spin equal to 3/2 is introduced phenomenologically and can participate as an intermediate state in the process. Two coupling constants describing transitions to the isobar and back again with absorption or emission of a photon are fitted from experiment. The remaining constant is chosen from the scattering of mesons by nucleons. The calculation is carried through to lowest order with damping in a charge independent theory. The results fit well the dependence on energy and angle for the cross-sections $\gamma + p' \rightarrow \pi^0 + p$ and $\gamma + p \rightarrow \pi^+ + n$. G. E. BROWN

539.18

3138. Meson production in meson-nucleon collisions. Y. Miyachi. Letter in *Progr. theor. Phys.*, **12**, *No.* 2, 243–4 (*Aug.*, 1954).

The differential cross-sections for π^+-meson production in the process $p + \pi^- \rightarrow \pi^- + \pi^+ + n$ are compared in lowest-order approximation for 210 MeV π^--mesons for pseudoscalar and pseudovector coupling. Stronger meson-nucleon than meson-meson coupling is assumed and the nucleons are treated non-relativistically. Higher-order calculations for one-pion states, using the Chew model, do not seem to change the qualitative features of the differential cross-section for pseudovector coupling. G. FIELD

539.18

3139. Charged photomesons from carbon. D. Luckey. *Phys. Rev.*, **97**, *No.* 2, 469–70 (*Jan.* 15, 1955).

Cross-sections per MeV meson energy per equivalent quantum for the production of π^+-mesons from carbon by 310 MeV bremsstrahlen have been measured in the angular range from 30° to 180°. Carbon data exist for those meson energies and angles which correspond to π^+ production from free protons by γ-rays of 200, 235, and 265 MeV. A comparison is made with production from hydrogen by giving the efficiency ε, defined as the ratio of production per proton in carbon to that in hydrogen. Various π^-/π^+ ratios are given for carbon. A.

539.18

3140. On the spin of the θ^0-meson. P. T. Matthews and A. Salam. *Phil. Mag.*, **46**, 150–4 (*Feb.*, 1955).

The θ^0-meson may be a scalar or a vector particle. The two possible interactions which account for its decay into two π-mesons are considered. The cross-sections (*a*) for the anomalous decay of θ^0 into two π-mesons and a γ-ray, and (*b*) for the production reaction $\pi^- + p \rightarrow \Lambda^0 + \theta^0$, are calculated, in the hope of finding a criterion to distinguish between the two spin values. A.

539.18

3141. Scattering of 119-MeV pions by deuterium. D. E. Nagle. *Phys. Rev.*, **97**, *No.* 2, 480–6 (*Jan.* 15, 1955).

The angular distributions for the scattering of negative pions by liquid deuterium were measured, using the 119 MeV pion beam of the Chicago cyclotron and scintillation counters. The values of the nonexchange scattering differential cross-section in the laboratory system for angles of 45°, 90°, and 135° are $8{\cdot}50 \pm 0{\cdot}31$, $5{\cdot}31 \pm 0{\cdot}20$, and $8{\cdot}36 \pm 0{\cdot}29$ in units 10^{-27} cm^2 steradian^{-1}. The differential cross-sections for the production of photons at the same angles and in the same units are $2{\cdot}20 \pm 0{\cdot}27$, $2{\cdot}41 \pm 0{\cdot}28$, and $3{\cdot}40 \pm 0{\cdot}38$. The total cross-section from transmission measurements is $(132 \pm 7) \times 10^{-27}$ cm^2. These values are somewhat less than the sum of the previously measured cross-sections for positive and for negative pions on hydrogen. A.

539.18

3142. Theory of multiple Coulomb scattering from extended nuclei. L. N. Cooper and J. Rainwater. *Phys. Rev.*, **97**, *No.* 2, 492–504 (*Jan.* 15, 1955).

Two independent methods are described for calculating the multiple scattering distribution for projected angle scattering resulting when very high-energy charged particles traverse a thick scatterer. The single scattering law for projected angle scattering is taken to be the Rutherford scattering law for projected angle scattering modified at small angles by electron shielding and at large angles by a nuclear form factor $\mathfrak{F}_n(\phi/\phi_0)$ which gives the effect of the finite nuclear size. The calculations can be carried through for any reasonable choice of $\mathfrak{F}_n$ and have been carried through for two suggested choices of $\mathfrak{F}_n$ for the examples of fast μ-meson scattering in lead slabs of thickness 2 cm and 5 cm, with good agreement for the two methods of calculation. The results are compared with the theories of Molière and Olbert. A.

539.18

3143. Scattering of 151-MeV positive pions by protons. R. A. Grandey and A. F. Clark. *Phys. Rev.*, **97**, *No.* 3, 791–7 (*Feb.* 1, 1955).

Nuclear emulsions have been exposed to the external positive pion beam of the Carnegie synchro-

cyclotron and have been scanned for elastic π–p scatterings. Seventy events have been found while scanning plates exposed to a final energy of 151 ± 7 MeV, which, combined with results obtained at Columbia and the recent accurate determinations of the total cross-section in this region by the Carnegie Group, yield a value for the differential cross-section of $d\sigma/d\Omega = (7{\cdot}7 \pm 2{\cdot}1) - (3{\cdot}1 \pm 2{\cdot}4) \cos\theta + (17{\cdot}3 \pm 7{\cdot}2)\cos^2\theta$ mb/sterad. The best Fermi type phase shifts calculated from the above are: $\alpha_3 = -26°$, $\alpha_{33} = 50°$, and $\alpha_{31} = 0°$. Recent data on pion-proton scattering at various energies are discussed, and it is found that the present data can be fitted with just three phase shifts which can be treated on semi-empirical models. A.

539.18

3144. The large-angle scattering of μ-mesons in iron. I. B. McDiarmid. *Phil. Mag.*, **46**, 177–89 (*Feb.*, 1955).

This was investigated by a method similar to that reported previously for lead [Abstr. 10533 (1954)]. The measured large-angle distributions are compared with the theories of Molière, Olbert and a modification of Olbert's theory which is based on a single-scattering cross-section inferred from recent electron-scattering measurements. At energies from several hundred MeV to about 4 BeV the measured distribution, at large angles, is not consistent with present Coulomb scattering theories in which the effects of the finite nuclear dimensions are included. As in the lead experiment, the number of large angles observed is in rough agreement with Molière's theory for a "point" nucleus. Some properties of the so-called anomalous scattering, which follow from the lead and iron experiments, are discussed. A.

539.185 : 539.172.4

3145. Attempt to detect the antineutrinos from a nuclear reactor by the $Cl^{37}(\bar{\nu}, e^-)A^{37}$ reaction. R. Davis, Jr. *Phys. Rev.*, **97**, *No.* 3, 766–9 (*Feb.* 1, 1955).

Tanks containing 200 and 3900 litres of carbon tetrachloride were irradiated outside the shield of the Brookhaven reactor in an attempt to induce the reaction $Cl^{37}(\bar{\nu}, e^-)A^{37}$ with fission-product anti-neutrinos. The experiments serve to place an upper limit on the antineutrino capture cross-section for the reaction of 2×10^{-42} cm^2 per atom. Cosmic-ray-induced A^{37} was observed and the production rate measured at 14 100 feet altitude and sea level. Measurements with the 3900 litre container shielded from cosmic rays with 19 feet of earth permit placing an upper limit on the neutrino flux from the sun. A.

539.185

3146. On the spatial distribution of neutrons slowed down in carbon and water. G. Holte. *Ark. Fys.*, **8**, *Paper* 15, 165–71 (1954).

The stationary density of slow, epi-thermal neutrons around a point source of fast neutrons has been studied. The calculations are made using methods developed in previous papers. Numerical values for the neutron density in homogeneous moderators of carbon and water respectively, are given in tables and diagrams for different values of the source energy. The validity of the much-used age-theory for these moderators has been studied in detail. For water this theory is practically useless, at least for high energy of the neutron source. A.

539.185

3147. Milne's problem with a point-source. J. P. Elliott. *Proc. Roy. Soc. A*, **228**, 424–33 (*March* 8, 1955).

Asymptotic solutions have been found, if capture is small, in the Milne problem with a point-source either on the boundary or in the scattering half-space. A.

539.185 : 548.74

3148. Diffraction of neutrons by crystals in vibration. M. Moshinsky. *Rev. Mexicana Fis.*, **2**, *No.* 3, 137–54 (*July*, 1953) In Spanish.

In accordance with the dynamical procedure developed by von Laue for the corresponding electromagnetic problem, the analysis is divided into two parts. In the first the scattering of neutrons by a vibrating nucleus is discussed with the help of a time-dependent generalization of Fermi's equivalent potential. In the second the superposition of the scattered waves from all the vibrating nuclei in the lattice is treated, and the differential cross-sections for elastic and inelastic scattering by the vibrating crystal are obtained. Under certain assumptions, the scattering of neutrons and of electromagnetic radiation by a vibrating particle show the resemblance that was predicted from the phenomenon of diffraction in time. A.

539.185

3149. Magnetic scattering of slow neutrons from O_2 gas. W. H. Kleiner. *Phys. Rev.*, **97**, *No.* 2, 411–18 (*Jan.* 15, 1955).

A general expression is derived for magnetic scattering of slow neutrons from oxygen gas which takes account of molecular rotation. The scattering derived on the basis of Meckler's ground electronic wave-function for O_2 is discussed. The validity of the static or semiclassical approximation is considered. Values are given for the total magnetic cross-section in laboratory co-ordinates based on Meckler's wave-function. The magnetic scattering does not appear to be sufficiently sensitive to changes in the wave-function to distinguish in practice between different reasonable approximate wave-functions. A.

539.185.08

3150. A neutron detector with uniform sensitivity as a function of energy from 0·5 to 6 MeV. P. Eberhard. *J. Phys. Radium*, **15**, *No.* 11, 765–6 (*Nov.*, 1954) In French.

A form of long counter, constructional details and method of testing are given. The effective cross-section of the detector was 1·75 cm^2 ± 10% and the counter is unaffected by γ-ray fluxes $<10^7$ per cm^2.sec. J. HUGHES

539.185.08

3151. International neutron-source calibrations. D. J. Hughes. *Nucleonics*, **12**, *No.* 12, 26–8 (*Dec.*, 1954).

The latest results of intercalibrations of neutron sources (mainly Ra–α–Be), at different laboratories in Belgium, Britain, France, Italy, Sweden, Switzerland and the United States, are summarized. L. R. SHEPHERD

539.185.08

3152. The time-of-flight velocity spectrometer for slow neutrons used at the Centre d'Études Nucléaires de Saclay. M. Galula, B. Jacrot and F. Netter. *J. Phys. Radium*, **15**, *No.* 12, 59 S–60 S (*Dec.*, 1954) In French.

A brief account of the spectrometer used in conjunction with the pile for measuring neutron spectra in the energy range 10^{-3} eV to about 100 eV.

M. A. GRACE

539.185.9

3153. Neutron damage to the structure of vitreous silica. J. S. Lukesh. *Phys. Rev.*, **97**, *No.* 2, 345–6 (*Jan.* 15, 1955).

The X-ray diffraction pattern of vitreous silica has been investigated before and after exposure to neutrons. Small, but significant, changes are observed. A relation between these changes and those caused by neutron damage to crystalline forms of silica is suggested. A.

STRUCTURE OF SOLIDS 539.2

539.213 : 539.4 : 534.39

3154. Fibre crystal formation by sonic polymerization in glasses. L. Holzapfel. Note in *Naturwissenschaften*, **41**, *No.* 17, 402 (1954) In German.

Increased elasticity and breaking strength in the fibre direction of a sonically polymerized silicone glass are shown on two photographs of the crushed glass. W. GOOD

539.213.1

3155. Glass formers. A. Winter. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 1, 73–5 (*Jan.* 3, 1955) In French.

A survey of the electronic structure of known glass-forming elements and mixtures shows that there are two types of glasses: (i) those made entirely of group VI elements, each with 4 *p*-electrons; (ii) those made with a group VI element and one or more elements from groups III, IV and V, containing at least 1 but less than 4 *p*-electrons. It is suggested that all such mixtures should form glasses under suitable conditions. R. O. DAVIES

539.213.28

3156. On the mechanism of aging in aluminium-silver alloys. II. Nature of the Guinier–Preston zone. K. Hirano and H. Sakai. *J. Phys. Soc. Japan*, **10**, *No.* 1, 23–30 (*Jan.*, 1955).

For Pt I, see Abstr. 2771 (1954). The process of the precipitation from supersaturated solid solution of aluminium containing from 5 to 53 weight % of silver, has been studied by the electrical resistance measurements. The discreteness between low-temperature and high-temperature ageing has been reconfirmed. The nature of the Guinier–Preston zone, which is the product of low-temperature ageing, has been studied in detail, the correlated phenomena with it, such as the intermediate maximum observed in the isothermal low-temperature ageing curve and the reversion phenomenon, have been satisfactorily interpreted in terms of the stability of the Guinier–Preston zone. A.

539.215.4

3157. The determination of the size distribution of small spherical particles embedded in a solid body by means of the circles of intersection seen in a plane section. F. Lenz. *Optik*, **11**, *No.* 11, 524–7 (1954) In German.

The size distribution of the circles of intersection can be determined in a light or electron microscope. A method of deriving the size distribution of the particles is suggested. Some difficulties that arise when only small numbers of circles can be seen are considered and methods of overcoming the difficulties are given. R. W. FISH

539.216.1 : 535.557

3158. Measurement of orientation in polystyrene monofilaments by means of double refraction. R. D. Andrews. *J. appl. Phys.*, **25**, 1223–31 (*Oct.*, 1954).

The molecular orientation in polystyrene monofilaments can be determined by measuring the optical double refraction, or birefringence, which the orientation produces. When the oriented filaments are observed with monochromatic light under a polarizing microscope, a pattern of interference fringes is seen which can be analysed. The general theory of this interference pattern is discussed, including consideration of the molecular basis of optical birefringence in polystyrene. Reversals of fringe order in the interference pattern can occur, but this complication can be handled by suitable methods. A number of experimental techniques useful in these studies are described. It is found that the birefringence is greater near the outside surface of the filaments than in the centre, and this can be understood in terms of the rate of cooling during the orientation process. A.

539.216.1 : 535.557

3159. Theory of orientation and double refraction in polymers. E. F. Gurnee. *J. appl. Phys.*, **25**, 1232–40 (*Oct.*, 1954).

Orientation and birefringence in linearly oriented amorphous polymers are discussed with particular emphasis on polystyrene type chains. A system of completely uncoiled parallel zigzag chains is defined as 100% orientation. The variation of birefringence with orientation is assumed to follow the same expression as that for the variation of polarization anisotropy with extension for a single random coil chain. With these assumptions and reasonable models for the completely uncoiled polystyrene chain it is possible to express any given birefringence as a percentage orientation. Methods are developed for the experimental determination of the birefringence at a particular point in an oriented monofilament instead of the usual determination of an average birefringence through the monofilament. The application of these methods to actual examples leads to reasonable values of the orientation. A.

539.217

3160. Reproducibility of diffusion measurements: time of anneal and method of counting radiation. C. T. Tomizuka and D. Lazarus. Letter in *J. appl. Phys.*, **25**, *No.* 11, 1443 (*Nov.*, 1954).

Careful studies of the self diffusion of Ag were made using the radioactive isotope Ag^{110}, counting independently both β- and γ-activity of layers of known

depth below the original surface after various annealing times. The results were entirely consistent with the conventional analysis in which the distances are normalized by a factor $t^{\frac{1}{2}}$ (t = time anneal) in contradiction to some previous reports. W. M. LOMER

539.217

3161. Effect of compressive stress on self-diffusion in zinc. A. W. LAWSON. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1948–9 (*Nov.*, 1954).

Recent measurements on the effect of stress on the self-diffusion coefficients of Zn by Liu and Drickamer [Abstr. 5020 (1954)] are shown not to be self-consistent by a factor of 500. It is suggested that faulty temperature control might be responsible. W. M. LOMER

539.217

3162. Dependence of the intermetallic diffusion coefficient upon concentration. J. MIZUNO, S. OGAWA AND T. HIRONE. *J. Phys. Soc. Japan*, **9**, *No.* 6, 961–6 (*Nov.–Dec.*, 1954).

A new method of determining the intermetallic diffusion coefficient is proposed. A thin layer of one metal was electrodeposited on the surface of another, and the surface concentration was examined by the X-ray back-reflection method during the process of diffusion. From the surface concentration *v.* time curves the diffusion coefficient was given as a function of concentration. This method was applied to the measurement of the intermetallic diffusion coefficient for the nickel-copper system at temperatures 800, 900 and 1000°C respectively. A discrepancy was found between the diffusion coefficients obtained from the nickel-deposited copper plates and from copper-deposited nickel plates. This is considered to originate from porosities formed near the diffusion interface due to the vacancy flow and from some properties of electrodeposited layer. A.

539.217

3163. Anisotropy of diffusion in grain boundaries. S. R. L. COULING AND R. SMOLUCHOWSKI. *J. appl. Phys.*, **25**, *No.* 12, 1538–42 (*Dec.*, 1954).

Grain boundary penetrations of radioactive silver into copper bicrystals having a common cubic direction have been measured using an autoradiographic technique. Diffusion occurred along directions forming an angle $\phi = 0°$, 45° and 90° with the common cubic direction. For very low angles of disorientation θ, no preferential intergranular penetration was observed; for low and intermediate relative orientations, grain boundary diffusion was found to be most rapid along the common direction ($\phi = 0°$); for high angles of misfit, little anisotropy of boundary diffusion was detected. The observed asymmetry about $\theta = 45°$ of the curves of grain boundary penetration *v.* θ is in agreement with the known dependence of the density of boundary dislocations on the angle between grains and on grain boundary direction. The anisotropy measurements may be qualitatively explained in terms of the distribution and relative amounts of elongated areas of "fit" and "misfit" in the grain boundary, and they confirm the earlier proposed model of grain boundaries in the region of angles where the simple dislocation model does not apply. A.

539.217 : 532.72

3164. Self-diffusion in sodium near the melting point. R. E. MEYER AND N. H. NACHTRIEB. Letter in *J. chem. Phys.*, **23**, *No.* 2, 405 (*Feb.*, 1955).

Radioactive tracer measurements in high purity Na were made in both liquid and solid to within 1/10th deg. C of the melting point. No evidence of premelting, and a genuine discontinuity at melting from $D_{solid} = 2{\cdot}16\times10^{-7}$ to $D_{liquid} = 4{\cdot}2\times10^{-5}$ is found. Diffusion in the liquid is represented by $D = 1{\cdot}10\times10^{-3}\exp(-2450/RT)$. W. M. LOMER

539.219

3165. The solubility of nitrogen in α-iron. H. U. ÅSTRÖM. *Ark. Fys.*, **8**, *Paper* 49, 495–503 (1954).

The solubility of nitrogen in α-iron has been determined by isothermal calorimetric measurements and by studying the elastic after-effect of samples in the shape of iron spirals. The values of the solubility obtained show good agreement. The dependence of the elastic after-effect on the concentration of the solute nitrogen in the spirals was measured in the whole solubility range available, the content of nitrogen being determined by weighing. The dependence was found to be non-linear, in contradiction to results given in the literature. The source of this non-linear relation is thought to be the interaction between the solute nitrogen atoms, and a formula for the elastic after-effect accounting for this phenomenon is derived from statistical considerations. The calculated curve of the after-effect is in good agreement with the experimental values. A.

539.219

3166. On the solid solubility of silver in aluminium. K. HIRANO AND Y. TAKAGI. *J. Phys. Soc. Japan*, **9**, *No.* 5, 730–5 (*Sept.–Oct.*, 1954).

Heating the specimens of aluminium-silver alloy which are in thermal equilibrium, from room temperature to above the two-phase boundary, the changes of specific heat and electrical resistance were examined: from the characteristic changes in them due to the resolution of precipitated phase, the solid solubility curve or "solvus" of silver in aluminium was determined. A remarkable change in the direction of the solvus at about 20 atomic per cent of silver and at 526°C, first observed by Raynor and Wakeman, was confirmed. The energy of solid solution and accompanying entropy change were also determined and shown plotted against silver content from 1·3 to 50 atomic per cent. Both curves show a bending which is probably attributable to the effect of the electronic band structure of pure aluminium metal. The energy of valence electrons in the solid solutions was calculated by means of the state density curve due to Matyáš, Axon and Hume-Rothery. It was found that in order to explain the observed increase of energy of the alloys, aluminium must be assumed to have 2·5 electrons per atom but not 3. A.

539.234

3167. State of the surface, and condensation of molecular jets. P. GARIN AND P. PRUGNE. Letter in *J. Phys. Radium*, **15**, *No.* 12, 829 (*Dec.*, 1954) In French.

Apparatus used and results obtained in a study of the condensation of zinc and cadmium on pure

aluminium, aluminium covered with a layer of alumina, calcium, copper and silver surfaces. The state of the surface (purity, outgassing, etc.) is considered of major importance. G. WITTENBERG

539.27

3168. Substance differentiation in the emission electron microscope (electrons released by oblique bombardment with an atomic beam). G. MÖLLENSTEDT AND W. HUBIG. *Optik*, **11**, *No.* 11, 528–39 (1954) In German.

The electron surface microscope, previously described [Abstr. 6841 (1953)], may be limited in its powers of differentiating between different substances because a film gradually builds up over the surface of the specimen, and masks the characteristic reflecting properties of the underlying material. It is shown that this film is similar to the carbon film used by König for making replicas for the electron microscope. The initial formation of this film is affected by the substrate material. Its growth can be considerably hindered by heating the specimen to 150°C.

A.E.I. RESEARCH LABORATORY

539.27

3169. Regularities in electron diffraction photographs of antimony layers with texture. U. ZORLL. *Z. Phys.*, **139**, *No.* 5, 649–54 (1954) In German.

Layers of rhombohedral Sb, evaporated on a collodion film *in vacuo*, with their (111) planes parallel to the film surface, show marked textures by transmission. The reflections are arranged on a system of straight lines, ellipses and hyperbolae. J. THEWLIS

539.27

3170. Lattice constants and texture of thin indium layers. U. ZORLL. *Z. Phys.*, **139**, *No.* 5, 654–7 (1954) In German.

Thin layers of In were evaporated *in vacuo* on to collodion films, and their electron diffraction diagrams compared quantitatively with that of LiF to determine the lattice constant. It was found that $a = 4{\cdot}615$ Å and $c = 4{\cdot}910$ Å. Most of the crystallites were oriented with the (111) planes parallel to the substrate, but other orientations were present. J. THEWLIS

539.27

3171. Artifice and artefact in the silica replica method. E. KINDER AND A. PUFF. *Z. wiss. Mikr.*, **62**, *No.* 2, 116–18 (*Dec.*, 1954) In German.

The ease of handling a silica replica, formed on a first replica of polystyrene or other material, is improved if the silica is backed with a layer of gelatine. Attention is drawn to means of preventing the silica film from splitting during subsequent manipulation and to the importance of keeping the film free of water droplets, which can produce artefacts in the final image. V. E. COSSLETT

539.27

3172. Quantitative investigations on plastic replicas. H. KIMMEL. *Z. wiss. Mikr.*, **62**, *No.* 2, 119–21 (*Dec.*, 1954) In German.

The Tolansky multiple beam method of interferometry has been used to test the faithfulness of reproduction in a replica of a simple ridge or step pattern. It is found that distortion occurs in the case of a single step, but that for a repeated pattern (e.g. a grating) the amount of distortion progressively decreases as the repeat distance decreases. A quantitative measure is proposed in terms of the ratio of the Fourier amplitude of the object to that of the replica surface. For the very fine details normally to be reproduced in electron microscopy the degree of faithfulness is very close to unity. V. E. COSSLETT

539.27

3173. A method for making thermoplastic replicas of a chosen region. F. LEONHARD. *Z. wiss. Mikr.*, **62**, *No.* 2, 129–37 (*Dec.*, 1954) In German.

A detailed description is given of a modification of the polystyrene-silica replica method of Heidenreich and Peck [*J. appl. Phys.*, **14**, 23–9 (*Jan.*, 1943)], designed to make it more suitable for repetitive use. With a special small press and an attachment to the tube of an optical microscope, replicas can be obtained of selected areas from which optical pictures are also taken. A further variant has been devised in which the replica is formed on a thin lacquer ("Zaponlack") film that is forced on to the specimen surface by the polystyrene block whilst the latter is softened. This "thermoplastic deep-drawing" method is able to cope with much more rugged surface relief than the usual replica methods. V. E. COSSLETT

539.27

3174. Anomalies in electron diffraction patterns of lead iodide. S. KUWABARA. *J. Sci. Hiroshima Univ. A*, **17**, *No.* 3, 377–82 (*March*, 1954).

The occurrence of contour lines in electron micrographs of PbI_2 films is related to the electron diffraction patterns of the films and the results considered in the light of the geometry of the apparatus and the dynamical theory of electron diffraction. J. THEWLIS

539.27

3175. The inner potential of copper. A. GOSWAMI. Letter in *J. sci. industr. Res.*, **13 B**, *No.* 10, 735–7 (*Oct.*, 1954).

An approximate estimate of the inner potential of copper is made from the displacement of electron diffraction spots obtained from a (110) face.

J. THEWLIS

539.27

3176. Protective films on magnesium observed by electron diffraction and microscopy. S. YAMAGUCHI. Letter in *J. appl. Phys.*, **25**, *No.* 11, 1437–8 (*Nov.*, 1954).

The film formed in boiling water consists of $Mg(OH)_2$. That formed in a solution of NaCl consists of $MgCl_2$ and $Mg(OH)_2$. The latter film is coarser than the former. J. THEWLIS

539.27 : 537.533.35

Trends in electron microscopy in the United States. *See Abstr.* 2787

539.27 : 539.23

3177. Thin metallic and colloidal films. J. P. BOREL. *Helv. phys. Acta*, **27**, *No.* 6, 485–9 (1954) In French.

This preliminary account emphasizes the value of the measurement and spectral analysis of "background noise" in electron diffraction experiments on very thin films. Electron microscope photographs of

4–40 mμ Ag-films, evaporated on collodion, silicon and caoutchouc, were obtained by focusing the beam on one part of the film and photographing another with a greatly reduced intensity. This minimized the effect of the electron beam on the films. R. A. WEALE

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

3178. Some applications of Fourier series in the numerical treatment of linear behaviour. F. C. ROESLER. *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 2, 89–96 (*Feb.*, 1955).

Certain functional relations common to various phenomenological theories, like the theory of linear visco-elasticity and the theory of linear electrical networks, may be written as integral equations of the convolution type. As the circular functions are eigenfunctions of the convolution type kernels, such equations can be solved by Fourier expansion. A number of possible applications of such Fourier expansions are indicated and the relevant details are worked out. The method centres on the evaluation of the eigenvalues for each kernel. The examples discussed refer to the theory of visco-elasticity and include the determination of the relaxation spectrum either from the dynamic elasticity as a function of frequency or from the stress relaxation as a function of time. [For earlier work see Abstr. 6046 (1954).] A.

539.31

3179. An iteration method for the determination of relaxation spectra. F. C. ROESLER AND W. A. TWYMAN. *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 2, 97–105 (*Feb.*, 1955).

The determination of relaxation spectra involves the numerical solution of certain linear, convolution-type integral equations of the first kind. A simple iteration method is shown by which some such equations may be solved. In the limit this is equivalent to the exact solution by means of Fourier integrals. If only moderate accuracy is required, the iteration method is sometimes less laborious than the use of Fourier series (preceding abstract), and in any case it involves only elementary arithmetical operations. As one illustration, the relaxation spectrum of polyisobutylene is found from the damping, for the whole domain over which published data are available. In the rubber–glass transition region the results agree well with those previously obtained for this region by use of Fourier series. As a second illustration, successive approximations to a fictitious single line spectrum are shown. A.

539.31

3180. Theory of elasticity and consolidation for a porous anisotropic solid. M. A. BIOT. *J. appl. Phys.*, **26**, *No.* 2, 182–5 (*Feb.*, 1955).

The author's previous theory of elasticity and consolidation for isotropic materials [*J. appl. Phys.*, **12**, 155–64 (1941)] is extended to the general case of anisotropy. The method of derivation is also different and more direct. The particular cases of transverse isotropy and complete isotropy are discussed. A.

539.312

3181. The relation between dynamic elastic modulus, internal friction, creep and stress relaxation in polymethyl methacrylate. E. FUKADA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 786–9 (*Sept.–Oct.*, 1954).

The dynamic Young's modulus and the internal friction of polymethyl methacrylate have been measured over a frequency range of 100–2000 c/s by the lateral vibration. The dynamic rigidity modulus and the internal friction have been measured over a frequency range of 0·2–1 c/s by the torsional vibration. The creep and stress relaxation have been also measured in a time range of 1–50 min. It was found that both creep and relaxation function are proportional to the logarithm of time. By making use of this creep function and assuming only the superposition principle, the dynamic elastic modulus and the internal friction were calculated as functions of frequency. No assumption about the distribution function of relaxation time was used. The agreement between calculated curves and the measured values is good when the parameter C is taken to be 0·09, where C represents the ratio of the slope of creep function against logarithm of time to the instantaneous strain. The experimentally observed C is 0·065. The stress relaxation function was calculated over a broader time range and was found not to be linear to the logarithm of time very soon after loading. But it was linear after about 1 minute and gave a reasonable agreement with the measured values. A.

539.319 : 532.51

3182. Second order effects in elasticity and hydrodynamics. M. REINER. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 372–9 (*March*, 1954; publ. *June*, 1954).

The significance of a "linear" relationship between stress and strain is arbitrary to the extent that the quantities to which the name "strain components" is given are arbitrary; a linear equation with one definition of strain is nonlinear with another. Some very different states of stress, any one of which could be regarded as related "linearly" with simple elastic shear, are illustrated. A stress, strain (or rate-of-strain) relation in which the stress tensor can be expressed as a series of "powers" of the strain (or rate-of-strain) tensor can be reduced to one in which no powers above the second occur; and such a form of equation is proposed to describe nonlinear effects, using any measure of strain. The phenomena arising from the occurrence of unequal normal pressures in shearing, associated with such an equation, are briefly reviewed. J. G. OLDROYD

539.319 : 534.21

3183. Acoustic methods of measuring relaxation spectra in solids. E. G. RICHARDSON. *Acustica*, **4**, *No.* 3, 537–43 (1954).

Methods of measuring (1) decrement, (2) breadth of resonance peak, (3) loss angle by observations at (*a*) varying frequencies, (*b*) varying temperatures. Propagation of (*a*) transverse, (*b*) torsional, (*c*) longitudinal waves in lengthy specimens, at infrasonic, audio and ultrasonic frequencies. Sorting out imaginary and real parts of propagation constants.

Prediction of relaxation spectra. Explanation in terms of visco-elastic models. A.

539.32

3184. Elastic constants of AgBr at 28°C. D. S. Tannhauser and A. W. Lawson. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2092 (*Dec.*, 1954).

Measured using an ultrasonic pulse technique in single crystals along the ⟨100⟩ and ⟨110⟩ directions. A large deviation from the Cauchy relation $C_{12} = C_{44}$ is shown. W. BARDSLEY

539.32

3185. Some dynamic mechanical properties of polyisobutylene over a wide temperature range. D. A. Thomas and D. W. Robinson. *Brit. J. appl. Phys.*, **6**, *No.* 2, 41–3 (*Feb.*, 1955).

A cantilever resonance method has been used to measure the complex Young's modulus of polyisobutylene from 90 to 560°K at a number of points in the frequency range 30–300 c/s. Using the method of reduced variables, the results have been expressed as a function of frequency at constant temperature and compared with other published data on this material over comparable reduced frequency ranges. Agreement is quite good over a limited reduced frequency range, but the present results predict a higher value for the real part of the modulus at infinitely high frequencies, and show the small dispersion peak in the imaginary modulus curve displaced to a higher reduced frequency. The validity of extrapolating the frequency shift factor to high and low temperatures is questioned, and suggested as a possible explanation for the discrepancies. A comparatively large value of the temperature coefficient of the modulus at 90°K suggests that an appreciable configurational entropy term is still contributing to the free energy of the polymer at these low temperatures. A.

539.37 : 535.41

3186. Use of nets for the experimental study of elastic and plastic phenomena. P. Daniu. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 25, 1769–71 (*Dec.* 20, 1954) In French.

A brief description is given of the use of moiré patterns in stress analysis. [See Abstr. 3335 (1954).] The pattern is obtained by fixing a rectilinear network on a model or on the actual material under investigation, and placing a second network on top. If the material is subjected to load, then observation of the pattern, seen either by transmitted light if the model is transparent or reflected light if it is opaque, enables the strain to be found. Three typical patterns are shown: the method is useful in two- and three-dimensional work and in dynamic and plastic studies. Advantages over photoelastic methods are listed. H. G. JERRARD

539.37 : 539.26

3187. Stress measurement by X-ray diffraction. H. R. Letner and S. R. Maloof. Letter in *J. appl. Phys.*, **25**, *No.* 11, 1440 (*Nov.*, 1954).

Determines the accuracy of X-ray measurements of surface stress in the presence of steep gradients normal to the surface. It is found that the method gives a value nearly equal to the weighted average of the stresses in the volume diffracting. J. THEWLIS

539.371

3188. On the behaviour of metal cables subjected to tensile forces. R. Goldschmidt. *Helv. phys. Acta*, **27**, *No.* 6, 508–12 (1954) In French.

The method consists in fixing the mid-point of the test piece, and extending one end of this by a known force, the extension being measured by extensometers and the torsion in this stressed piece being restored to zero by rotation at the mid-point by a lever system. The other (free) end of the piece therefore rotates, and this rotation is measured. A theory is developed applicable to the elastic behaviour of a bundle of wires twisted into cable form. A. J. KENNEDY

539.374

3189. A new simple measuring method for temperature dependence of mechanical behaviors of high polymer solids. K. Ito. *J. Sci. Res. Inst.* [*Tokyo*] **48**, 154–65 (*Sept.*, 1954).

A simple and rapid measuring method for the temperature dependence of mechanical behaviour of high-polymer solids is proposed. This method is easily performed by obtaining Rockwell Number/Temperature curves using a Rockwell hardness testing machine with a small test piece, which is heated at some constant rate of temperature rise. Thus thermal behaviour of high-polymer solids, for example transition to entropy elasticity, "flow" phenomenon of linear polymers, both effects of reinforcement and network polymers in laminated plastics, can be clearly demonstrated by Rockwell Number/Temperature curves. These results are verified by effective stress-strain curves at various temperatures, compressive creep curves in the hot state and mechanical properties at room temperature. A.

539.389.3

3190. The relaxation of stress in undrawn Amilan. H. Fujita and A. Kishimoto. *J. Phys. Soc. Japan*, **9**, *No.* 5, 867–72 (*Sept.–Oct.*, 1954).

539.389.3

3191. On the ageing of aluminium-silver alloys in thin sheets. A. Winkelmann. *Z. angew. Phys.*, **7**, *No.* 1, 7–12 (1955) In German.

Sheets a few hundred Å thick were examined by electron diffraction. It was found that the transformation from the cubic supersaturated solid solution to precipitated hexagonal Ag_2Al occurred much more quickly and at lower temperatures than in massive specimens. This is attributed to the absence of opposing stresses in the thin sheets. The basal plane of the hexagonal phase is parallel to the (111) planes of the matrix. W. M. LOMER

539.389.4

3192. Elastic hysteresis. H. Frinken and E. Kappler. Note in *Naturwissenschaften*, **41**, *No.* 20, 472 (1954) In German.

The area of the hysteresis loop after a given plastic strain varies as the fourth power of the upper limit of the stress cycle (the lower limit is always zero). In Ni, at different plastic strains on cycling between the stress-strain curve and zero, the area varies linearly with the stress; when the area is plotted against stress for variously heat treated samples, all the straight lines intersect in a single point. On subsequent annealing

the area of the curve decreases at 200°C, whereas it softens only above 400°C. W. M. LOMER

539.389.4

3193. Elastic hysteresis and internal stresses. H. FRINKEN AND E. KAPPLER. Note in *Naturwissenschaften*, **41**, *No.* 20, 472–3 (1954) In German.

The line breadth of X-ray patterns from material which has been under cyclic stress behaves very similarly to the area of the hysteresis loop (see preceding abstract). The line breadth is also given as function of the angle between the incoming beam and the specimen axis. W. M. LOMER

539.4.016.3 : 548.5

3194. Self-hardening of a Frank–Read source. F. EDER AND P. TÄUBERT. Note in *Naturwissenschaften*, **41**, *No.* 20, 473–4 (1954) In German.

When the dislocation line rotates round the anchored ends of the source, it leaves a line in spiral form, representing a high local stress. These spirals gradually reduce the effective length of the source and produce hardening. The expressions derived have a formal similarity with those describing recrystallization, and by considering recovery and recrystallization of the spiral region to be competing processes, the form of the curve of recrystallization nucleus density v. annealing temperature is explained. W. M. LOMER

539.4.016.3 : 548.7

3195. Quenching-in of lattice vacancies in pure gold. J. W. KAUFFMANN AND J. S. KOEHLER. Letter in *Phys. Rev.*, **97**, *No.* 2, 555 (*Jan.* 15, 1955).

Gold wires of 99·999% purity were quenched from temperatures between 690 and 900°C to room temperature in 10 millisec by a He blast, and to liquid nitrogen in a further $\frac{1}{2}$ sec. Resistance measurements at liquid He temperature enabled the energy of formation of vacancies to be deduced as $1{\cdot}28 \pm 0{\cdot}03$ eV and the activation energy for vacancy movement to be $0{\cdot}68 \pm 0{\cdot}03$ eV. The sum of these values is in good agreement with measurements of the activation energy of self-diffusion. W. M. LOMER

539.43

3196. Failure and survival in fatigue. A. M. FREUDENTHAL AND E. J. GUMBEL. Letter in *J. appl. Phys.*, **25**, *No.* 11, 1435 (*Nov.*, 1954).

In the formulation of a statistical distribution function of the fatigue life for a constant stress amplitude, difficulty is encountered in expressing the finite, but small, probability of a specimen surviving apparently indefinitely provided the stress is sufficiently low. This is equivalent to saying that the precise "endurance limit" is hard to determine. The difficulties can be reconciled with previous treatments [Abstr. 4425 (1953)] by introducing an auxiliary survivorship function, which enables the true distribution to be derived. A. J. KENNEDY

539.434 : 518.5 : 621.3.012.8 : 621.372.2

3197. The physical and computing significance of an electrical analogue of creep and recovery. A. J. KENNEDY. *Brit. J. appl. Phys.*, **6**, *No.* 2, 49–58 (*Feb.*, 1955).

The instrument described is basically a simple non-inductive transmission line, made up of identical sections, with the capacitance divided into recoverable and irrecoverable elements, in series, by the use of rectifiers. A voltage programme can be set up and applied automatically to simulate the stressing, and the charge taken by the network, with time, is integrated and recorded as the creep strain analogue. The simple power-type creep curve exhibited by solids (in particular the cubic type) is accurately reproduced. The time-functions which relate the character of the creep in metals with the times of stress and off-stress are very similar to those obtained with the analogue. Creep recovery, permanent flow and creep under changed stress (including reversed stress) can all be satisfactorily handled. The character of transient creep and recovery does not, therefore, demand special models involving arbitrary distributions of relaxation times. Problems must be set up on the machine using data obtained from short-term tests: calculations of prolonged intermittent creep can then be quickly completed. No account can at present be taken of temperature changes. On this basis, a comprehensive analogue creep computer, of a much higher operating speed, appears possible. A.

539.537

3198. Flash associated with high-velocity impact on aluminium. W. W. ATKINS. Letter in *J. appl. Phys.*, **26**, *No.* 1, 126–7 (*Jan.*, 1955).

By spark photography, a time history was recorded of the growth of the luminous impact flash produced by a high-velocity spherical projectile perforating an aluminium target. The spark system actually recorded only one shadowgraph per perforation, and the continuous history was obtained by recording a number of impacts with varied delay times between the instant of impact and the time the spark fired. Large fragments from the entry side of the target emerged through the flash generated on that side and were clearly visible after 250 μsec. The duration of the luminous flash was 4–5 msec. Small fragments diverged radially at 60–70° to the path of the projectile and a displacement-time plot of them indicated their speed to be about 10 500 ft/sec. A. C. WHIFFIN

539.576

3199. An experimental investigation of non-metallic wear. G. HUGHES AND R. T. SPURR. *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 2, 106–10 (*Feb.*, 1955).

The rate of wear of a non-metallic substance is shown to be given by the equation $W = KL/p$ (where W is the wear per unit sliding distance, L the load and p the hardness) over a wide range of sliding conditions provided the variation of the hardness of the specimen with temperature is taken into account. A.

539.62

3200. Analysis of the effect of various factors on metal transfer and wear between specimen pairs of same metal and same shape. I. The basic scheme of formulation of metal transfer and wear. I.-M. FENG. *J. appl. Phys.*, **26**, *No.* 1, 24–7 (*Jan.*, 1955).

The fundamental scheme of formulation of the amount of metal transfer and wear is based upon the theory suggested in Abstr. 9101 (1952). The basic terms used in formulating metal transfer and wear are (1) the potential amount of metal transfer M_t^*; (2) the mechanical factor of the chance of metal transfer ϕ_m; (3) the thermal factor of the chance of metal transfer ψ_θ; and (4) the adhesion factor of the

chance of metal transfer X_a. The expression for the amount of metal transfer M_t from one specimen to another is $M_t = M_t^* \phi_m \psi_\theta$, when ψ_θ is bigger than X_a, and is $M_t = M_t^* \phi_m X_a$ when X_a is bigger than ψ_θ. The equation for the amount of wear M_w represented by the weight loss of a specimen is $M_w = M_t^* \phi_m (1 - \psi_\theta)$, when ψ_θ is bigger than X_a, and is $M_w = M^* \phi_m (1 - X_a)$, when X_a is bigger than ψ_θ. A.

539.62

3201. An analysis of the effect of various factors on metal transfer and wear between specimen pairs of same metal and same shape. II. Effect of the surrounding atmosphere. I.-M. FENG. *J. appl. Phys.*, **26**, *No.* 1, 28–32 (*Jan.*, 1955).

The discussion is limited to the case where the surface layer is thinner than the average depth of roughening. The surrounding atmosphere influences the adhesion factor X_a through its effect on adhesion that depends on such factors as the nature and thickness of the surface layer and also the degree of plastic roughening. The influence of the surface layer on the thermal factor ψ_θ is similar to its influence on X_a. Because of the lack of quantitative knowledge about its effect on adhesion and diffusion, the effect of surrounding atmosphere on metal transfer and wear is discussed qualitatively. The dependence upon such factors as the temperature, gas pressure, time of exposure, etc., of the effect of physically adsorbed and chemical-compound surface layers on metal transfer and wear is also discussed. A.

539.62

3202. The friction and the mechanical properties of solid krypton. F. P. BOWDEN AND G. W. ROWE. *Proc. Roy. Soc. A*, **228**, 1–9 (*Feb.* 15, 1955).

An experimental study has been made of the frictional behaviour and of the hardness of solid krypton. It is found that the friction is nearly independent of load over the range investigated. At temperatures close to the melting point the friction is very low and the frictional behaviour is similar to that of ice. When the temperature is well below the melting point the friction is much higher, about $\mu = 0{\cdot}7$, although the surface forces of the van der Waals crystal must be weak. An explanation of this high friction is suggested by the measurements of hardness. These show that the solid is extremely soft at temperatures near the melting point. Even at liquid-hydrogen temperatures, where the creep becomes negligible, the yield pressure is only about $0{\cdot}3$ Kg/mm^2. Thus large areas of contact are formed between two surfaces which are placed together under load. It is suggested that, as with other plastic solids, the friction is primarily determined by the shearing of these contact areas formed by local plastic flow. An estimate is made of the activation energy for flow, deduced from creep measurements, giving the low value of about 1 to 2 kcal/g mol, and an approximate value of 4×10^6 dyn/cm^2 is computed for the critical shear stress of undeformed krypton at liquid-hydrogen temperature. A.

539.62

3203. Friction between unlubricated metals: a theoretical analysis of the junction model. A. P. GREEN. *Proc. Roy. Soc. A*, **228**, 191–204 (*Feb.* 22, 1955).

Friction between unlubricated metals is supposed to be due to shearing of junctions formed by adhesion between minute asperities on the sliding surfaces. The theory is elaborated in this paper to give a clearer picture of how the stresses and deformations in junctions are determined. First, it is shown that the distinctive feature of steady sliding is that, on the average, the surfaces move parallel to each other. Under this condition the deformation of individual junctions, from their formation to fracture, has been studied using Plasticine models. Theoretical plastic solutions for junctions with simple shapes provide rough estimates of the stresses involved and a qualitative picture of a junction's "life cycle." The effects of ductility and hardness are discussed. Mechanisms are suggested to account for high friction or seizure between outgassed surfaces *in vacuo*. Finally, certain limits of validity of the theory are pointed out and related to the breakdown of Amontons's laws. A.

539.67

3204. Internal friction in glass. III. Strain relaxation. P. L. KIRBY. *J. Soc. Glass Technol.*, **38**, 548 T–560 T (*Dec.*, 1954).

For Pt II, see Abstr. 1305 (1955). The elastic after-effect phenomena of a hard borosilicate glass are studied at a range of temperatures from 250° to 500°. The results are used to assess the magnitude of the viscoelastic relaxation and the value of the mean relaxation period. An approximate form of the distribution of the relaxation periods about the mean value is obtained. A.

539.67

3205. Internal friction of metal single crystals. J. WEERTMAN. *J. appl. Phys.*, **26**, *No.* 2, 202–10 (*Feb.*, 1955).

Semiquantitative calculations were made of that portion of the internal friction of annealed and moderately cold-worked metal single crystals which is due to dislocation motion. The calculations were made on the basis of a qualitative theory of Nowick. It is shown that Nowick's theory leads to reasonable orders of magnitude of the observed internal friction and changes of the modulus of elasticity. At low temperature or at high frequencies (megacycle range) Nowick's hysteresis mechanism becomes inoperative and theories of Koehler and Eshelby have to be considered to calculate the internal friction. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123 : 541.13

3206. Concerning the coexistant phases in the system NaCl–H_2O above 374°c. J. FOGO, S. W. BENSON AND C. S. COPELAND. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1942–3 (*Nov.*, 1954).

That the solutions the conductances of which were measured [Abstr. 5071 (1954)] above 374°c are one-

phase systems is maintained in spite of the contention of Corwin and Owen [Abstr. 9701 (1954)] that the conductances varied in a manner consistent with the separation of two phases. W. GOOD

541.124

3207. Reactions with activated solids. J. A. HEDVALL. *Chalmers Tekn. Högsk. Handl., No.* 151, 23 *pp.* (1954).

A descriptive survey. W. GOOD

541.124

3208. Some complexities in the reaction system: $H_2 + I_2 = 2HI$. S. W. BENSON AND R. SRINIVASAN. *J. chem. Phys.*, **23,** *No.* 1, 200–3 (*Jan.*, 1955).

Existing thermal and kinetic data are sufficient to show that in the reaction $H_2 + I_2 = 2HI$, free radical processes may contribute significantly to the overall rate at temperatures above 600°K. This provides a reasonable explanation for some of the anomalies observed in this system and indicates that further kinetic study of the system is desirable. A.

541.124

3209. Kinetics of the thermal *cis-trans* isomerization of dideuteroethylene. J. E. DOUGLAS, B. S. RABINOVITCH AND F. S. LOONEY. *J. chem. Phys.*, **23,** *No.* 2, 315–23 (*Feb.*, 1955).

This has been studied from 450° to 550°C over a pressure range of 0·9 cm to 31 cm Hg in two quartz reactors. The rate is pressure-dependent over the entire pressure range. It is concluded that at 0·9 cm the reaction is a homogeneous, unimolecular reaction. A high-pressure activation energy of 65 kcal and frequency factor of 10^{13} sec^{-1} are deduced. At higher pressures the reaction is sensitized by processes attendant on polymerization, which occurs as a side reaction with propylene as the principal product. The relation of this study to other work on substituted ethylenes is discussed briefly, as well as a few other topics pertinent to the results obtained. A.

541.124 : 539.155.2

3210. C^{13} isotope effect in the thermodecomposition of ethyl bromide. H. L. FRIEDMAN, R. B. BERNSTEIN AND H. E. GUNNING. *J. chem. Phys.*, **23,** *No.* 1, 109–13 (*Jan.*, 1955).

The C^{12}–C^{13} fractionation factor in the decomposition of gaseous ethyl bromide has been measured from 350–450°C, using samples of natural isotope abundance. The rate constants are defined as follows: $CH_3CH_2Br \rightarrow CH_2{=}CH_2 + HBr$, k_1; $CH_3C^*H_2Br \rightarrow CH_2{=}C^*H_2 + HBr$, k_2; $C^*H_3CH_2Br \rightarrow C^*H_2{=}CH_2 + HBr$, k_3. At 400°C, the C^{12} enrichment of the first fraction of ethylene from decomposition of the ethyl bromide is $S_0 \equiv 1 + \varepsilon_0 = 2k_8/(k_2 + k_3) = 1{\cdot}0079 \pm 0{\cdot}0006$, with a temperature coefficient of $-2{\cdot}8 \times 10^{-5}$/°C. The primary and secondary isotope effects are defined, respectively, as $\beta = k_1/k_2 - 1$ and $\gamma = k_1/k_3 - 1$; thus, to a good approximation, $\beta + \gamma = 2\varepsilon_0$. According to theory, $\beta > \gamma \geqslant 0$, so that $\varepsilon_0 < \beta \leqslant 2\varepsilon_0$ and $\varepsilon_0 > \gamma \geqslant 0$. From the data of 400°C one then obtains as an upper limit $(k_1/k_2)_{max} \leqslant 1{\cdot}0159 \pm 0{\cdot}0012$. This is significantly lower than the value $k_1/k_2 \geqslant 1{\cdot}036$ calculated for the rupture of an isolated C–Br bond. The present results, therefore, favour a mechanism involving the direct intramolecular elimination of HBr. A.

541.124 : 539.16.08

3211. Kinetics of homogeneous and heterogeneous isotopic reactions. M. HAÏSSINSKY. *Cahiers de Phys., No.* 51, 52–68 (*Sept.*, 1954) In French.

Isotopic effects cause the equilibrium constants of isotopic exchange reactions to be different from unity. Here reactions involving a radioactive isotope are investigated, this isotope acting as indicator. Homogeneous and heterogeneous reactions are considered and reactions between metals and ions in particular. Relations are derived for the reaction rates and for the coefficients of autodiffusion. In the case of heterogeneous reactions a relation for the reaction area is also suggested. The methods are illustrated by some examples. A. J. TAYLOR

541.124.2

3212. Initiation processes in the autoxidation of fatty acid esters and allied substances. N. A. KHAN. Letter in *J. chem. Phys.*, **22,** *No.* 12, 2090 (*Dec.*, 1954).

It is suggested that Farmer's theory [*Trans Faraday Soc.*, **42,** 228 (1946)] on autoxidation does not adequately explain oxidations at double bonds and at α methylenic groups. Here autoxidation of purified cyclohexene was investigated experimentally. On the basis of this experimental evidence it is found that a monomeric monohydroperoxide is formed at the initial stages, during an induction period. This hydroperoxide could be formed through either electron transfer or hydrogen atom transfer via a transition state consisting of a six-membered cyclic ring. The energy of the reaction can thus be accounted for. A. J. TAYLOR

541.124.2

3213. Reply to Khan's letter, "Initiation processes in the autoxidation of fatty acid esters and allied substances." L. BATEMAN. Letter in *J. chem. Phys.*, **22,** *No.* 12, 2090–1 (*Dec.*, 1954).

See preceding abstract. The induction periods observed by Khan are stated to be caused by very slow oxygen absorption. At observable rates of oxidation the chain mechanism is dominant. Energy data of the reactions are found to support the free radical theory. A. J. TAYLOR

541.126

3214. The reaction zone in gaseous detonations. G. B. KISTIAKOWSKY AND P. H. KYDD. Letter in *J. chem. Phys.*, **22,** *No.* 11, 1940–1 (*Nov.*, 1954).

The Zeldovich–von Neumann theory of the reaction zone in detonation waves was tested by the X-ray absorption method. This theory states that the detonation wave consists of a shock moving at the detonation velocity and leaving heated and compressed gas behind. The mixture used consisted of 70% H_2 and 30% O_2 with a small amount of Xe (10–15 mm Hg), so that adequate X-ray absorption took place. The waves were produced by the detonation of acetylene–oxygen mixtures. In the range 115–15 mm Hg the duration of the reaction zone was found to be roughly inversely proportional to the square of the pressure of the reaction mixture. When A at 309 mm Hg was used instead of Xe, there was no evidence of the reaction zone: the added gas therefore increases the reaction rate. The peak

density is never as high as the expected value, which must be due to the resolving power of the apparatus.

A. J. TAYLOR

541.126 : 533.75

An equation of state for the detonation of condensed explosives. *See Abstr.* 2493

541.127

3215. On the problem of chemical reaction rates. I. PRIGOGINE. *Cahiers de Phys., No.* 52, 49–58 (*Nov.*, 1954) In French.

The theory is investigated and surveyed from a thermodynamic and a statistical point of view. A method is developed for the calculation of the rates of irreversible reactions. This is based on the hypothesis of equilibrium in chemical kinetics, i.e. the Boltzmann distribution of velocities is supposed to remain unchanged during the reaction process.

A. J. TAYLOR

541.127

3216. Some remarks to Golden's rate theory. I. YASUMORI AND S. SATO. Letter in *J. chem. Phys.*, **22,** *No.* 11, 1938 (*Nov.*, 1954).

When applying Golden's theory [Abstr. 6486 (1949)] to the reaction $H_2 + H \rightarrow H + H_2$ the authors find the results to be unsatisfactory. It is suggested that the disagreements originate in the perturbation potential used, which must be too large, and in the first approximation which corresponds to Born's zero-order approximation. That good results are obtained for the reaction $H_2 + Br \rightarrow H + HBr$ must be due to the fact that the activation energy of the reaction is nearly equal to the zero-point energy difference between reactants and products.

A. J. TAYLOR

541.127

3217. Adequacy of the Born approximation in the calculation of chemical reaction rates. A reply to Yasumori and Sato. S. GOLDEN. Letter in *J. chem. Phys.*, **22,** *No.* 11, 1938–9 (*Nov.*, 1954).

See preceding abstract. The criticism made by Yasumori and Sato on the application of Born's approximation in the calculation of reaction rates is supported. The inapplicability is shown in calculations on the ortho-para conversion of hydrogen. A second-order treatment is also carried out, but this second term is of a much larger order than the first term.

A. J. TAYLOR

ELECTROCHEMISTRY 541.13

541.132

3218. Single ion free energies and entropies of aqueous ions. W. M. LATIMER. *J. chem. Phys.*, **23,** *No.* 1, 90–3 (*Jan.*, 1955).

Single-ion free energies of hydration were assigned by Latimer, Pitzer, and Slansky by choosing a set of ion radii which made both negative and positive ions fall on the theoretical Born curve in a plot of ΔF against $1/r'$. The r' values were the crystal ion radii plus 0·1 Å for negative ions and plus 0·85 Å for positive ions. It is now shown that this assignment of single-ion free energies is consistent with the single-ion entropies of hydration if $\bar{S}_{H^+}$ is $-2 \cdot 1$ (the Eastman value). The ΔS values are proportional to Z/r' and the tentative suggestion is made that it is the temperature coefficient of r' which leads to the Z/r' function. It is proposed that the ΔF values be used to calculate a consistent set of radii of aqueous ions which will take into account co-ordination numbers and polarization.

A.

541.133

3219. The ionic conductivity of dilute potassium chloride solutions at centimetric wavelengths. V. I. LITTLE AND V. SMITH. *Proc. Phys. Soc.* [*London*] *B,* **68,** *Pt* 2, 65–74 (*Feb.*, 1955).

A differential method is described for measuring the ionic conductivity of potassium chloride solutions at 3×10^9 c/s. The results reveal that a strong dispersion region exists at concentrations below 0·5 normal, which may be explained in terms of the perturbations by the applied field of a shell of water molecules surrounding the ion at a mean distance of 6 Å.

A.

541.133.1 : 539.16.08

3220. An attempt to detect the electrolytic migration of radioactive interstitial silver ions produced in a silver chloride crystal by slow neutron irradiation. S. G. COHEN AND M. SCHMORAK. *Bull. Res. Coun. Israel,* **3,** *No.* 4, 312–15 (*March*, 1954; publ. *June*, 1954).

Slow neutron capture and subsequent γ-emission recoil of a radioactive silver nucleus is expected to increase the density of interstitial Ag atoms. It was hoped that these might be detected by their electrolytic concentration at the cathode. No measurable effect was obtained, implying an upper limit to the mobility of the ions which in turn leads to the result that the activation energy for interstitial Ag ion migration is $< 0 \cdot 23$ eV.

W. M. LOMER

541.135

3221. The fundamentals of electrochemical kinetics. R. AUDUBERT. *Cahiers de Phys., No.* 51, 43–51 (*Sept.*, 1954) In French.

The problem of overvoltage (the difference between the thermodynamically predicted potential and the one actually found, which is always larger) is investigated. A formerly developed logarithmic relation describing this effect is inadequate. The theory developed is based on the fact that the discharge of an ion at the electrode is a slow reaction, dehydration having to take place first. A relation is derived for the voltage and this is verified by results of experiments on various electronic reactions. The energies of activation are also determined.

A. J. TAYLOR

541.135

3222. Ionization of strong electrolytes. III. Proton magnetic resonance in nitric, perchloric, and hydrochloric acids. G. C. HOOD, O. REDLICH AND C. A. REILLY. *J. chem. Phys.*, **22,** *No.* 12, 2067–71 (*Dec.*, 1954).

For Pt II, see *J. Amer. Chem. Soc.*, **66,** 13–16 (*Jan.*, 1944). Since the proton magnetic resonance shift in an acid is a colligative property, the derivation of degrees of dissociation requires assumptions which cannot be tested directly. Results derived from measurements of this resonance shift in nitric acid and in perchloric acids are in sufficient agreement with

earlier results obtained from a specific property (intensity of Raman lines) to confirm the interpretation of the shift. The value 22 has been found for the thermodynamic dissociation constant of nitric acid, the value 38 for perchloric acid. The association of nitric acid in aqueous solutions containing more than 50 mole % of acid is reflected in the shift. Differences in the limiting slopes of the resonance shift of the proton in various acids at high dilution are interpreted as due to different influences of the anions on the association of water. A.

541.135.4

3223. On the mechanism of electrolytic transport in solid intermetallic phases. W. Seith and H. Wever. Note in *Naturwissenschaften*, **41**, *No.* 19, 447 (1954) In German.

Two Cu electrodes are sweated on to a CuAl alloy (16·5% wt. Al). The concn. gradient between the Cu and the alloy produces at 895°C a pure γ-phase flanked on both sides first by β-phase then α-phase and finally Cu. After d.c. electrolysis (1 hr) it is found that in addition to already observed [Abstr. 7820 (1954)] growth and dissolution at the boundaries between α- and β-phase there is between β- and γ-phase a considerably larger growth and dissolution respectively on the cathodic and anodic sides of the boundary. A consideration of transport numbers at this phase boundary and in the β-phase lends support to the view that the charge carriers drag along the defect ions. W. GOOD

541.135.5

3224. Concentration overpotential at reversible electrodes. H. Rubin and F. C. Collins. *J. phys. Chem.*, **58**, *No.* 11, 958–62 (*Nov.*, 1954).

A study has been made of rate- and diffusion-controlled currents at a planar reversible electrode under applied potentials such that the reverse reaction makes an appreciable contribution to the over-all process. The ferrocyanide, ferricyanide and molybdocyanide systems were studied. The data obtained confirm an earlier prediction that the current under a potential substantially less than that corresponding to "limiting" current will converge at sufficiently long times to the value of the "limiting" current at the corresponding time. Values of the specific rate constants were calculated from the data and enable an approximate determination of the fraction of the ions which react upon impinging on the electrode. The relation between the specific rate constants and the applied potential agrees with the Eyring theory of absolute reaction rates and reasonable values of the activation free energies are obtained. A.

541.135.5

3225. Hydrogen overvoltage and electrode material. A theoretical analysis. P. Rüetschi and P. Delahay. *J. chem. Phys.*, **23**, *No.* 1, 195–200 (*Jan.*, 1955).

It is shown on a theoretical basis that the overvoltage for hydrogen evolution on various metals and for otherwise identical conditions of electrolysis is essentially a linear function of the heat of adsorption of atomic hydrogen on the electrode. This relationship is deduced on the assumptions that the effect of the backward electrode reaction—the oxidation of hydrogen—can be neglected, and that the current is controlled by the discharge of hydrogen ions. This is the case for overvoltages larger than 0·1–0·15 V. The relationship between overvoltage and heat of adsorption is tested for metals for which reliable overvoltage data are available, that is for Ag, Be, Cd, Cr, Cu, Fe, Ga, Hg, In, Ni, Pb, Tl. The argument is based on a kinetic equation for hydrogen overvoltage and on the use of potential energy curves for the initial and final states. These curves are determined from spectroscopic data. Heats of adsorption of atomic hydrogen are calculated by assuming the additivity of the M–M and H–H bond energies. Calculated heats of adsorption are listed for 25 metals. It is also shown that there is no correlation between hydrogen overvoltage for various metals and the electronic work function of these metals. A.

541.135.6

3226. Electrochemical polarization in isopropyl ether. J. A. Rider. *J. chem. Phys.*, **23**, *No.* 1, 61–5 (*Jan.*, 1955).

Measurements have been made of the polarization effects in electrical conduction through isopropyl ether. This liquid was chosen because its conductivity is intermediate between that of dielectric liquids and water. Correlation of experimental results in this range with the Jaffé theory had not heretofore been checked. The present results provide a bridge across the gap which formerly existed in polarization measurements between conductivities of 10^{-6} $ohm^{-1}cm^{-1}$ and 10^{-18} ohm^{-1} cm^{-1}. Observations were made of the time dependence of current following the application of various voltages to the electrodes of a cell containing the liquid. Measurements in the present range broaden the pattern of agreement of the Jaffé theory with experiment. Such agreement now extends from semiconductors and aqueous solutions to dielectric liquids. In all cases good quantitative agreement is obtained provided part of the conductance is attributed to carriers of considerably lower mobility than the ordinary conductivity carriers. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.15

3227. Chemical dosimetry of radiations giving different ion densities. An experimental determination of G values for Fe^{2+} oxidation. L. Ehrenberg and E. Sæland. *JENER Publ.*, *No.* 8, 25 *pp.* (1954).

The oxidation of air equilibrated $FeSO_4$ in dilute H_2SO_4 by X-rays and by particle radiations resulting from the interaction of pile neutrons with different elements added to the solution has been examined. The following G values (Fe^{3+}/100 eV) were obtained: U^{235} fission fragments 3·0 ± 0·9; $B^{10}(n,\alpha)$ Li^7 4·0 ± 0·4; N^{14} (n,p) C^{14} 7 ± 1; Li^6 (n,α) T 5·4 ± 0·3, from which 6·5 ± 0·7 is calculated for the triton; 175 kV X-rays 17·4 ± 0·8. Since for 160 MeV protons G is found to be equal to (16·5 ± 1) Fe^{3+}/100 eV it is concluded that G is a function only of the ion density (linear energy transfer), not of other properties of the ionizing particle, and that once this function is known the reaction can be used for the dosimetry of all

radiations including fast neutrons. An ion chamber determination of the latter agrees well with the actinometric dose. Since G_{Fe}/G_{Ce} is found to vary within a wide range of ion densities a simultaneous application of ferrous and ceric sulphate dose meters can be used for an estimation of the average ion density of a polyenergetic radiation. The G values of the particles emanating from boron and lithium are found to be independent of the pile position and of the background intensity. Since, further, dG/dT of densely ionizing radiations (represented by fast neutrons) is found to be zero, it is proved that under the actual conditions the effects due to densely and sparsely ionizing radiations applied simultaneously are additive. Fe^{3+} was determined photometrically at 465 mμ as thiocyanate complex. When 0·7 cm^3 3N KSCN are added to 3 cm^3 Fe solution, optimum conditions of sensitivity (molar extinction 8500), stability, and temperature dependence are obtained. A.

541.15

3228. Chemical effects of (d, p), $(n, 2n)$, and (γ, n) activation of iodine. R. H. SCHULER. *J. chem. Phys.*, **22**, *No.* 12, 2026–9 (*Dec.*, 1954).

The organic retentions for (d, p), $(n, 2n)$, and (γ, n) activation of iodine in liquid methyl and ethyl iodide, containing added iodine, have been found to be equal to the retentions observed in radiative neutron capture. This demonstrates that the chemical effects are independent of the recoil energy of the activated nucleus, of the mode of nuclear formation, and of variation of fragmentation effects within the recoil track. In the absence of scavenger iodine, the increase in retention due to radiation damage is less than 10% in all cases studied. A.

541.15

3229. Decomposition of methyl alcohol–water solutions by Co^{60} gamma radiation. W. R. MCDONELL AND S. GORDON. Letter in *J. chem. Phys.*, **23**, *No.* 1, 208 (*Jan.*, 1955).

Rates of formation of H_2, CO, CH_4, formaldehyde, and ethylene glycol during γ-ray irradiation of methyl alcohol in water (dose rate $= 2{\cdot}4 \times 10^{20}$ eV/litre. min.) are all linear, giving G-values of 4·0, 0·16, 0·24, 1·3, and 3·0 respectively. Corresponding values for irradiation with 28 MeV He ions are 3·46, 0·23, 0·36, 1·67 and 1·74. Attention is drawn to the ethylene glycol–formaldehyde ratio in the two cases, and it is suggested that formaldehyde is formed in the small, highly energized regions of initial energy absorption while the glycol results from chemical species escaping out of these regions. (See following abstract.)

C. B. ALLSOPP

541.15

3230. Decomposition of methyl alcohol–water solutions by Co^{60} gamma radiation. W. R. MCDONELL. Letter in *J. chem. Phys.*, **23**, *No.* 1, 208–9 (*Jan.*, 1955).

The effect of concentration of methyl alcohol (range 100 to 1 volume per cent alcohol) during its decomposition by γ-rays is described. Formaldehyde production falls off linearly with decreasing methyl alcohol while ethylene glycol remains at a high value until low alcohol concentrations are reached. This result is in keeping with the hypothesis set out in the preceding abstract. C. B. ALLSOPP

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18.041.3

3231. Electrical dehydration of tar emulsions. H. A. HOWE AND C. A. R. PEARCE. Note in *Brit. J. appl. Phys.*, **6**, *No.* 2, 68–9 (*Feb.*, 1955).

The emulsion is subjected to an alternating voltage (350–1000 volts); with a low-temperature tar, coalescence of the droplets occurs, but with a commercial tar, solid particles (carbon?) form a network of chains in which the droplets are held separate from one another. Illustrative photographs are given.

S. J. GREGG

541.18.051.3

3232. Development of emulsions due to self nucleation. H. WAKESHIMA. *J. Phys. Soc. Japan*, **10**, *No.* 1, 65–70 (*Jan.*, 1955).

Based on the formulae for the absolute rate of self-nucleation in condensed systems and also for the growth of droplets, derived by the author, the process of development of emulsions in solutions supersaturated with dissolved liquid, when the metastable state is broken by self-nucleation, is approximately treated. Relations giving such quantities as the threshold condition for the appearance of turbidity, and the number density of droplets, are obtained. A.

541.182.2 : 531.66

3233. Inertial impaction of aerosol particles on cylinders. J. B. WONG, W. E. RANZ AND H. F. JOHNSTONE. *J. appl. Phys.*, **26**, *No.* 2, 244–9 (*Feb.*, 1955).

This was investigated to determine the relationship between the efficiency of impaction and the inertial parameter, the Reynolds number of flow, and the effect of interception. The impaction of sulphuric acid aerosols of nearly uniform size ranging from 0·6 to 1·4 μ dia., on two platinum wires, 29 and 83 μ dia., and two tungsten wires, 53 and 106 μ dia., was measured at several velocities of flow past the wires. Reynolds numbers ranged from 13 to 330. For values of the square root of the inertial parameter $\Psi^{\frac{1}{2}}$ below 1·4, the experimental efficiencies of impaction agree with those predicted by Langmuir and Blodgett for potential flow and by Landahl and Herrmann for a Reynolds number of 10. The experimental values are higher than the calculated values for $\Psi^{\frac{1}{2}}$ greater than 1·4. The theoretical prediction that a critical value of $\Psi^{\frac{1}{2}}$ exists at approximately $\frac{1}{4}$, below which inertial impaction does not occur, was verified. A.

541.182.33

3234. Approximate calculation of the distribution of dust deposited by a horizontal jet of air. R. M. KAPLAN. *Zh. tekh. Fiz.*, **24**, *No.* 6, 1041–8 (1954) In Russian.

541.182.5 : 535.434

3235. Light scattering from gel-forming systems during and after setting. I. Aluminium molybdate and thorium arsenate gels: intensity measurements. R. L. DESAI AND V. SUNDARAM. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 598–608 (*Sept.–Oct.*, 1954).

The measurement of the intensity of light scattered

in different directions during the setting of gel-forming systems of aluminium molybdate and thorium arsenate shows that the size and anisotropy of the particles increase continuously during gelation. The ratio $I_{45°}/I_{135°}$ is found to increase continuously during the process of gelation and it has been inferred from the final values of these ratios that the particles in aluminium molybdate gels are probably rod-shaped while those in thorium arsenate are probably disk-shaped. The ultimate size and number of the particles is found to increase with an increase in the amount of potassium molybdate or potassium arsenate in the corresponding gel-forming mixture while the reverse is observed when the amount of aluminium nitrate or thorium nitrate, as the case may be, is increased. A.

541.182.5 : 535.434

3236. Light scattering from gel-forming systems during and after setting. II. Sodium stearate in octyl alcohol and sodium stearate in decyl alcohol: depolarization measurements. K. P. Buch and V. Sundaram. *Proc. Nat. Inst. Sci. India*, **20**, *No.* 5, 609–19 (*Sept.–Oct.*, 1954).

The measurement of the depolarization factors, ρ_u, ρ_v and ρ_h, of the light scattered in different directions from gel-forming systems of sodium stearate in octyl and in decyl alcohols has shown that the particles in these systems are anisotropic and of appreciable size. The changes taking place in the values of the depolarization factors of the transversely scattered light during the cooling of these systems have shown that the particles decrease in size and in anisotropy during gelation. The size of the final particles seems to be bigger in gels of lower concentrations than in those of higher ones. An attempt has been made to explain the observed results on the consideration of the behaviour of soap in polar solvents. A.

541.183.022 : 532.137

A rotational viscometer for surface films. *See Abstr.* 2456

CHEMICAL STRUCTURE 541.2/.6

541.24 : 539.16.08

3237. Determination of the molecular weights of polyesters by means of radioactive labelling. E. G. Hoffmann and H. Hoberg. *Z. Elektrochem.*, **58**, *No.* 8, 646–51 (1954) In German.

Describes an improved ebulliometric method involving the use of the Menzies–Wright vapour-pressure-type differential thermometer and its application for determining the molecular weight of polyethylene polymers. Results obtained with different solvents, while differing widely from those obtained by viscosimetric methods, agree very well with each other. The reliability of ebulliometric results was corroborated by condensing suitable polyesters with diols and subsequent labelling by esterification with $CH_3 \langle\rangle {}^{35}SO_3H$. The values of molecular weights evaluated by means of the radioactive end groups agree well with those obtained by ebulliometric method. F. LACHMAN

541.57

3238. The polarizabilities of carbon–carbon bonds. C. W. Bunn and R. de. P. Daubeny. *Trans Faraday Soc.*, **50**, *Pt* 11, 1173–7 (*Nov.*, 1954).

The refractive indices and density of crystals of hexatriacontaine, $C_{36}H_{74}$, have been measured and used to calculate the polarizabilities along and across the C–C bond. If the figures given by Denbigh for the C–H bond are accepted, the anisotropy of the C–C bond is found to be much less than that given by the calculations of Wang, and Denbigh, from Kerr and depolarization data. A.

541.62

3239. Polymorphism in solution of *cis*- and *trans*-β-methoxy-*p*-nitrochalcone. Y. Urushibara, F. Iimura and K. Ikeda. Letter in *J. chem. Phys.*, **22**, *No.* 11, 1943–4 (*Nov.*, 1954).

It was recently found that the stable form of this molecule (m. pt. 65°c) was a *cis*-form and that two labile polymorphs melting at 78° and 81°c were the same *trans*-forms with identical spectra. By systematic precipitation from various solvents ten different *cis*-forms were obtained which in heptane solution showed five different u.v. spectra. Five *trans*-forms were prepared by irradiation of the *cis*-forms. All *cis*- and *trans*-forms exist as monomers in solution. This is borne out by their spectra, their solubilities and by the fact that the various species undergo stepwise transition through some states on irradiation, finally forming an equilibrium mixture which is the same for all cases. It is indicated that some "hindered-rotational isomers" are formed by the combined effects of π-electron interaction and steric restriction. A. J. TAYLOR

541.62 : 535.343–15 : 535.375.5

3240. Spectroscopic studies of rotational isomerism in fluorinated ethanes. I. 1,2-difluoro-1,1,2,2-tetrachloroethane. R. E. Kagarise and L. W. Daasch. *J. chem. Phys.*, **23**, *No.* 1, 113–18 (*Jan.*, 1955).

The Raman spectra of solid and liquid $CFCl_2$–$CFCl_2$ have been investigated, and the observed frequency shifts ($\Delta\nu$ cm^{-1}), relative intensities, and depolarization factors are presented for the latter. The infrared absorption spectra of the liquid in the 2–36 μ region, and of the solid and vapour in the 2–22 μ region have also been studied. The behaviour of the infrared and Raman spectra as a function of temperature and upon solidification was anomalous in that no changes in the relative intensities of the spectral lines were observed. Two possible explanations of the spectroscopic data are considered, neither of which is completely satisfactory. The assumption of a single molecular species, corresponding to a large energy difference, is apparently in conflict with the number of observed Raman frequencies, while the assumption of two forms of almost equal energy ($\Delta H < 300$ calories per mole) is inconsistent with the persistence of all lines upon solidification. A.

541.62 : 535.343–15 : 535.375.5

3241. Spectroscopic studies of rotational isomerism in fluorinated ethanes. II. 1,2-dibromo-1,1,2,2-tetrafluoroethane. R. E. Kagarise and L. W. Daasch. *J. chem. Phys.*, **23**, *No.* 1, 130–4 (*Jan.*, 1955).

The Raman spectrum of liquid CF_2Br–CF_2Br has

been investigated, and the observed frequency shifts ($\Delta\nu$ cm^{-1}), relative intensities and depolarization factors are presented. The infrared absorption spectrum of the liquid in the 2–34 μ region, and of the solid and vapour in the 2–22 μ region have also been studied. On the basis of observations of the Raman spectrum of the liquid and the infrared spectrum of the vapour, liquid, and solid it is concluded that CF_2Br–CF_2Br exists as two isomeric species. Of these, the *trans*-form (C_{2h}) is the more stable, while the *gauche*-(C_2) is probably the higher energy form. The value of $\Delta H°$ for the reaction *trans*-(C_{2h})$\rightarrow$ *gauche*-(C_2) was found to be 925 $\pm$ 50 calories/mole in the liquid and 945 $\pm$ 50 calories/mole in the vapour state. A.

541.64

3242. Slow relaxation mechanisms in concentrated polymer solutions. J. D. Ferry, M. L. Williams and D. M. Stern. *J. phys. Chem.*, **58**, *No.* 11, 987–92 (*Nov.*, 1954).

The contributions of the slowest relaxation mechanisms to time-dependent mechanical behaviour in concentrated polymer solutions can be derived from dynamic viscosity, stress relaxation, or (according to a recent theory of DeWitt) apparent viscosity in non-Newtonian flow. The results of such measurements are compared for four samples of polyisobutylene, one of polystyrene, and one of polyvinyl acetate. They are in close agreement with one exception. For samples not too heterogeneous with respect to molecular weight, the time-dependent behaviour at the slow end of the time scale can be approximately predicted by a modification of the theory of Rouse, the only quantities needed being the molecular weight and steady flow viscosity. The elastic compliance of a linear polymer in steady-state flow is dominated by the slow relaxation mechanisms; according to the modified Rouse theory, it is $J = (2/5)M_{z+1}M_z/M_w cRT$, where c is concentration in g/cm^3 and the other symbols have their usual significance. A.

541.64

3243. Distribution of charged polymers at equilibrium in a centrifugal field. J. S. Johnson, K. A. Kraus and G. Scatchard. *J. phys. Chem.*, **58**, *No.* 11, 1034–9 (*Nov.*, 1954).

Equilibrium ultracentrifugation of monodisperse polymer systems in the presence of supporting electrolytes is discussed with particular emphasis on low molecular weight polymers of relatively high charge. Errors introduced in the estimation of molecular weights by neglect of this charge are evaluated. An equation is developed for the determination of molecular weights or degrees of aggregation of charged polymers in the presence of supporting electrolyte. Application of this equation to the usual centrifuge data involving refractive index gradients is described. A.

541.651

3244. Spectrophotometric study of the isomerization of various thermochromic spirans. O. Chaudé. *Cahiers de Phys.*, *No.* 51, 75–119 (*Sept.*, 1954) In French.

For previous part, see Abstr. 10618 (1954). Hypotheses concerning the mechanism of the isomerization of the thermochromic spirans are discussed. The mechanism of phototropy in general, and the relation between the visible absorption and the passage from one form of the spiran molecule to the other are considered. The effects of solvents on the equilibrium constant and the velocity constants, on the change of entropy, heats of reaction, energies of activation, and spectra are dealt with. A. J. Mee

541.651

3245. Spectrophotometric study of the isomerization of various thermochromic spirans. O. Chaudé. *Cahiers de Phys.*, *No.* 52, 38–74 (*Nov.*, 1954) In French.

See preceding abstract. The difference of enthalpy, ΔH, and the difference of entropy, ΔS, caused by the introduction of substituents into the spiran skeleton is considered. The effect on ΔH and ΔS on the spectra of different substituents in the condensed benzene nucleus containing O is dealt with. The effect for variations of the heterocyclic part of the molecule, the part of the molecule capable of opening being kept the same, and the effect of steric hindrance are also considered. All the results confirm Wizinger's theory of an open bipolar form of molecule. Other methods of studying the problem, e.g. by consideration of electrical moments are briefly discussed. The methods of preparation and the physical constants of the compounds used are given. A. J. Mee

CHEMICAL ANALYSIS 543/545

545.72 : 538.22

3246. Magnetic susceptibility of liquid ozone–oxygen mixtures. C. Brown, C. K. Hersh and A. W. Berger. *J. chem. Phys.*, **23**, *No.* 1, 103–9 (*Jan.*, 1955).

The data needed for analysis of liquid ozone–oxygen mixtures by measurement of magnetic susceptibility are presented. Volumetric preparation of liquid ozone–oxygen mixtures in equilibrium with the vapour phase is described. A permanent magnet at the temperature of the solutions provided the key for use of the Quincke (U-tube) method for magnetic susceptibility. Results at $-195°$ and $-183°$C show a linear relation between the magnetic susceptibility of the solutions and weight per cent oxygen at low oxygen content. Above about 10% oxygen the specific susceptibility of oxygen in solution decreases significantly. At $-183°$C, the ratio X_s/X_0 of specific susceptibility of oxygen in solution to that of pure liquid oxygen decreased from 1·30 at low concentrations to 1·13 at 27·6% oxygen, the two-liquid phase boundary. The limiting ratio at $-195°$C was 1·42. The discontinuity in magnetic susceptibility was used to establish the compositions at the phase boundaries; 9·2 and 91% by weight oxygen at $-195°$C, 27·6 and 70·2% at $-183°$C. A.

545.822

3247. Quantitative spectrographic analysis of ancient coins. M. R. Ricard and J. Condamin. *J. Phys. Radium*, **15**, *No.* 12, 85 S–86 S (*Dec.*, 1954) In French.

A method is described suitable for the analysis of rare coins which cannot be treated chemically. Spark spectra are taken between the metal to be analysed and a graphite electrode. The intensity ratio of the Cu II 2544·80 Å and the Ag II 2756·51 Å lines is

determined and compared with that of samples of known composition. The sensitivity of the method is satisfactory. A. J. TAYLOR

545.822 : 539.155.2

3248. Further investigations in the spectro-isotopic assay technique for lithium. G. K. WERNER, D. D. SMITH, S. J. OVENSHINE, O. B. RUDOLPH AND J. R. MCNALLY, JR. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 202–5 (*March*, 1955).

Photoelectric methods have been applied to a spectro-isotopic technique for the analysis of isotopes of lithium utilizing the isotope shift of 0·16 Å. Sample time and precision have been considerably improved due to both the photoelectric method and improvements in hollow cathode and source design. At the 30% isotope abundance level the precision of analysis is ±0·46% of the lower abundance isotope. A.

545.827

3249. Activation analysis determines sodium content of aluminium alloys. R. C. PLUMB AND R. H. SILVERMAN. *Nucleonics*, **12**, *No.* 12, 29–31 (*Dec.*, 1954).

Na content of the Al alloy is determined by irradiation in a thermal neutron flux followed by chemical extraction of the sodium activity and determination of the Na^{24} by γ-counting, using a comparison with a known Na sample that has been taken through an identical process. The neutron flux should be as free from fast neutrons as possible to minimize the $Al^{27}(n, \alpha)Na^{24}$ reaction. 1% accuracy is possible with Na contents of about 0·01%. L. R. SHEPHERD

545.844 : 539.16.08

3250. Identification of radioactive atomic species by means of paper chromatography. H. GÖTTE AND D. PÄTZE. *Z. Elektrochem.*, **58**, *No.* 8, 636–41 (1954) In German.

By adding separately carrier-free radioisotopes of Cs, Sr, Ba, Y, Ce, In and Cd (or a corresponding mixture of isotopes) to a mixture consisting of the same neutral elements (long-life U-fission products, not precipitable by H_2S from a solution with high HCl content), and by subjecting the mixture of carriers to paper chromatography, it has been possible to identify the radioactivities involved by measuring the distribution of activity over the chromatographic spots. F. LACHMAN

CRYSTALLOGRAPHY 548

548.24

3251. The crystallographic aspect of the mechanical twinning in metals. H. KIHÔ. *J. Phys. Soc. Japan*, **9**, *No.* 5, 739–47 (*Sept.–Oct.*, 1954).

To investigate twinning dislocations of metals, a simple crystallographical calculation is done, assuming that atomic movements are periodic as the twinning plane moves, that there is no diffusion, and that atoms come to new twin lattice sites from their most neighbouring original lattice sites. The shear strain S, Burgers vector $\boldsymbol{b}_t$ and its associated atomic movements $\boldsymbol{U}$, and the twin boundary structure are obtained for any crystallographic plane. It is shown that $\boldsymbol{U}$ may be easily demonstrated by using a "modified lattice" in which $\boldsymbol{b}_t$ diminishes to zero. Compared with various twinning planes, the observed twinning planes have the following characteristic: their S is the smallest, but their $|\boldsymbol{b}_t|$ and $|\boldsymbol{U}|$ are not. And when their S is equal to others, the twinning planes which have smaller $|\boldsymbol{b}_t|$ are liable to twin. There are several twinning planes, which it is possible to twin, e.g. {431} of β-Sn, and {100}, {531}, {221} of Bi type. In $\{10\bar{1}1\}$ of Mg, $S = 0{\cdot}353$, and the K_2 plane is one such as $(1\bar{3}20)$, which is somewhat rotated around the axis normal to $(10\bar{1}1)$. A.

548.52

3252. Interferometric and X-ray investigation of the growth of long-chain fatty acid crystals. I. Polymorphism and polytypism in palmitic acid crystals. A. R. VERMA. *Proc. Roy. Soc. A*, **228**, 34–50 (*Feb.* 15, 1955).

548.574

3253. An observation of circular patterns in the vicinity of small-area alloyed germanium *p-n* junctions. N. HOLONYAK, JR. *J. appl. Phys.*, **26**, *No.* 1, 121–3 (*Jan.*, 1955).

Alloyed germanium *p-n* junctions of 0·1 to 0·2 mm diameter or less have been alloyed upon crystals of roughly ten times greater linear dimensions such that when these units are suitably electrolytically etched, ring formations (both scattered rings and tracks of overlapping rings) occur on the crystal faces in the neighbourhoods of the junctions. Best current evidence indicates that the observed effects are etch produced. An explanation of this is given in terms of the action of bubbles accompanying the etching procedure. A.

ATOMIC AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

3254. Statistics of two-dimensional lattices with many components. T. KIHARA, Y. MIDZUNO AND T. SHIZUME. *J. Phys. Soc. Japan*, **9**, *No.* 5, 681–7 (*Sept.–Oct.*, 1954).

The statistics of the two-dimensional Ising lattice, for which each lattice site may take one of two states, has been partly generalized to the following model: each lattice site may take one s state, and each pair of neighbouring sites in different states has a common excess energy, J, compared with a pair of neighbouring sites in a same state. The partition function for the square lattice has a temperature symmetry and the Curie temperature, T_c, is given by $(s-1)\exp(-2J/kT_c) + 2\exp(-J/kT_c) - 1 = 0$, ($k$ is the Boltzmann constant). Although the partition function itself has only been obtained in the form of power

series valid in low- and high-temperature regions, it is highly probable that for any finite s the specific heat is infinite at the Curie temperature. The transition is not the normal phase transition of the first order which the Bragg–Williams approximation predicts for this lattice with $s \geqslant 3$. A.

548.7

3255. Dynamics of simple lattices. H. B. Rosenstock. *Phys. Rev.*, **97**, *No.* 2, 290–303 (*Jan.* 15, 1955).

The critical points (points where $\partial\omega/\partial x_i = 0$ for all $i = 1, 2, 3$) of the frequency ω of the lattice vibrations in wave-number space (x_1, x_2, x_3), shown by Van Hove to exist for a very general class of crystals, are located for the monatomic simple, face-centred and body-centred cubic lattices. The position and nature of the resulting singularities in the frequency distribution are found as a function of the ratio of force constants for second-nearest neighbours and nearest neighbours, and the qualitative features of the frequency distribution are thus determined. A method for using the information so obtained to determine the frequency distribution quantitatively is outlined. A.

548.7 : 539.152.2

3256. Nuclear spin relaxation by translational diffusion. II. Diffusion in a b.c.c. lattice. H. C. Torrey. *Phys. Rev.*, **96**, *No.* 3, 690 (*Nov.* 1, 1954).

For Pt I, see Abstr. 2868 (1954). The calculations previously reported of nuclear spin relaxation time when relaxation is influenced by random-walk processes have been extended to the case of random walk to nearest-neighbour positions in a body-centred cubic lattice. Some corrigenda of the previous work are noted. A.

548.7 : 536.631

3257. Vibration spectra and specific heats of cubic metals. I. Theory and application to sodium. A. B. Bhatia. *Phys. Rev.*, **97**, *No.* 2, 363–71 (*Jan.* 15, 1955).

A model for monovalent metals is proposed, on the basis of which the secular equations determining the frequencies of the normal modes of vibration are derived for body-centred and face-centred cubic metals. In contrast to the two force constants occurring in the usual treatments based on the Born–von Kármán model, each of these equations—one for each type of lattice—contains three force constants which may be identified with the three independent elastic constants of a cubic metal. The limitations of the model are discussed. The frequency spectrum of sodium, and hence its specific heat C_v at constant volume, are calculated. It is found that the agreement between the observed and calculated values of C_v is more satisfactory in the entire relevant temperature range, and especially at low temperatures, than that obtained by Bauer using the customary two force-constant model. A.

548.7

3258. Elastic spectrum of copper from temperature-diffuse scattering of X-rays. E. H. Jacobsen. *Phys. Rev.*, **97**, *No.* 3, 654–9 (*Feb.* 1, 1955).

Measurements have been made of the temperature-diffuse scattering of X-rays from a single crystal of copper at 300°K by using crystal monochromated Cu $K\alpha$ radiation. The measurements were analysed by the method of Laval and James to give dispersion curves of frequency v. wave vector for longitudinal and transverse waves in the 100, 110 and 111 directions. These results were then expressed in terms of the generalized force constants of the Born theory of lattice dynamics. By considering the interaction of first, second and third neighbours, nine force constants are involved, and these have been evaluated from the dispersion curves. These force constants appear in the secular equation of frequency v. wave vector and constitute the necessary data for computing a complete vibrational frequency spectrum. Such a spectrum has been calculated from the secular equation, by machine computation, for 3417 wave vectors. From this spectrum a specific heat curve was calculated and compared with experiment in the range of 15°K to 100°K. A.

548.7

3259. Formation energy of superlattice in Ni_3Fe. III. Kinetics of the superlattice at the formation stage with long range order. S. Iida. *J. Phys. Soc. Japan*, **10**, *No.* 1, 9–22 (*Jan.*, 1955).

For Pt II, see Abstr. 10633 (1954). The superlattice formation of Ni_3Fe in steady temperature annealings (at 500°C, 480°C and 460°C) was studied by direct observation of the heat of evolution and by measurement of specific heat on heating after each treatment. The multiple-step character of the formation process of this superlattice disappeared gradually by lowering the temperature of anneal. All results are plotted on the same internal-energy/temperature plane. The diagram is well explained by the theoretical treatment of the process which divides it into two steps, with and without the long-range order. But a process of the third type was found, which remains after the second process has been completed. This becomes more distinct when the annealing temperature is lowered. For instance, when the disordered specimen was rapidly cooled to 460°C, and annealed at this temperature, it was observed that the development of order looks as though it reaches an apparent saturation after about 80 hours annealing. But measurements of specific heat on heating of the corresponding specimen showed that the internal energy of the specimen is about 170 cal/atom higher than that of the true equilibrium state at 460°C. This type of process, which has a relaxation time of the order of a month, will presumably be related to the antiphase problem. The nucleation and antiphase problems in superlattice are also discussed. The specimen, which was quenched from 700°C shows an anomalous generation of heats between 230°C and 420°C on heating. This will be an important phenomenon for the formation process of this superlattice. A.

548.7

3260. Temperature dependence of electron mobility in AgCl. F. C. Brown. *Phys. Rev.*, **97**, *No.* 2, 355–62 (*Jan.* 15, 1955).

By using improved crystal counter techniques, electron mobility has been investigated as a function of temperature in AgCl. The measurements were made on annealed samples carefully grown from the melt in which the range of conduction electrons was of the order of 10^{-4} cm/volt.cm^{-1} of electric field strength. At high fields electron trapping in the

volume of the crystal is less important and observed mobility is shown to become a constant independent of field. At 86°K, drift mobility was found to be 274 cm^2/volt.sec and was reproducible to within 10% for several samples. The data on mobility can be fitted down to 86°K by an expression of the form $\mu = 2{\cdot}54 \times 10^5 T^{-\frac{3}{2}}$, which would suggest interaction of the electrons mainly with acoustic vibrations of the lattice. However, there exists the possibility of scattering by impurities or other imperfections which in combination with optical scattering might also lead to the observed results. Strains play an important role in this material and are shown to be associated both with shallow 0·1 eV traps and with deeper traps. The average energy for production of one electron-hole pair by β-rays is $7{\cdot}5 \pm 0{\cdot}5$ eV. The range of holes in the samples tested, from 86°K to 150°K, was at least less than $\frac{1}{10}$ that of electrons. A.

548.7

3261. Slow electrons in a polar crystal. R. P. FEYNMAN. *Phys. Rev.*, **97**, *No.* 3, 660–5 (*Feb.* 1, 1955).

A variational principle is developed for the lowest energy of a system described by a path integral. It is applied to the problem of the interaction of an electron with a polarizable lattice, as idealized by Fröhlich. The motion of the electron, after the phonons of the lattice field are eliminated, is described as a path integral. The variational method applied to this gives an energy for all values of the coupling constant. It is at least as accurate as previously known results. The effective mass of the electron is also calculated, but the accuracy here is difficult to judge. A.

548.7

3262. Methods of calculating the crystalline electric field. J. KANAMORI, T. MORIYA, K. MOTIZUKI AND T. NAGAMIYA. *J. Phys. Soc. Japan*, **10**, *No.* 2, 93–102 (*Feb.*, 1955).

Two convenient methods are developed for calculating the coefficients of expansion of the crystalline potential in spherical harmonics. One consists in extending Evjen's elementary method of obtaining Madelung's constant, dividing the lattice into multipoles and summing their contributions in an elementary way, and the other is an extension of Bertaut's Fourier method of obtaining the electrostatic lattice energy of a point-charge lattice and that of a point-dipole lattice. For the latter, two slightly different methods are proposed. Applications to NaCl-type and CsCl-type lattices and to FeF_2 and CoF_2 lattices are given, and the merits and disadvantages of the methods are discussed. A.

548.7

3263. Defect states and transport processes in ionic crystals. K. HAUFFE AND B. ILSCHNER. *Z. Elektrochem.*, **58**, *No.* 7, 467–77 (1954) In German.

After dealing carefully with the thermal equilibrium concentration of defects (interstitial ions and vacancies of either sign) in pure, impure and nonstoichiometric crystals of infinite extent, the boundary between two phases is considered. The way in which the concentration in the boundary layers is controlled by space charge is investigated. The transport processes are considered, and the currents of both kinds of ions in the boundary layers found and used to discuss the rate of oxidation of a metal. The influence of electronic conductivity in materials where the defects produce semiconductivity is also dealt with. The oxidation of Zn is used as a detailed example.

W. M. LOMER

548.7

3264. Relation between evaporation spirals and the structure of grain boundaries. S. AMELINCKX AND E. VOTAVA. Note in *Naturwissenschaften*, **41**, *No.* 18, 422–3 (1954).

Evidence for the existence of screw dislocations at grain boundaries of NaCl has been obtained by microscopic examination after etching or slow evaporation at 780°–800°C. A. R. STOKES

548.7

3265. A mechanism for the displacement of ions in an ionic lattice. J. H. O. VARLEY. Letter in *Nature* [*London*] **174**, 886–7 (*Nov.* 6, 1954).

The multiple ionization (>double) of negative ions by incident radiation produces positively charged ions, which are then ejected by the very strong repulsive Coulomb forces from normal nearest-neighbour pos. ions, into energetically more favourable interstitial sites, leaving behind neg. ion vacancies. Some observations on the intensity and distribution of radiation-induced colour centres in alkali halides, difficult to interpret on a "billiard ball" collision mechanism, are readily explained with the aid of this new mechanism. A. D. LE CLAIRE

548.7

3266. Formation energy of lattice defect in simple oxide crystals. J. YAMASHITA AND T. KUROSAWA. *J. Phys. Soc. Japan*, **9**, *No.* 6, 945–53 (*Nov.–Dec.*, 1954).

Determining the interionic potentials in MgO, CaO and SrO crystals phenomenologically, the authors found that the affinity of the O^{--} ion has a different value in each crystal. Using these potentials they computed the formation energy of the Schottky defect in these crystals and found that the results are reasonable. Finally they investigated the deviation from Cauchy-relations in MgO, using Lowdin's many-body forces. A.

548.7

3267. Dislocation energies and choice of slip plane in face-centered cubic metals. A. J. E. FOREMAN AND W. M. LOMER. *Phil. Mag.*, **46**, 73–6 (*Jan.*, 1955).

Calculations of the energy of dislocations on various slip planes in Al, Cu and Au indicate that the choice of slip plane is probably not controlled directly by this quantity. It is suggested that the energy of the screw dislocation is lowered by dissociation in the close-packed plane, and that dislocations are trapped into this plane as they pass through the screw orientation. The possible importance of dislocation mobility is briefly discussed. W. M. LOMER

548.7 : 539.4.016.2

3268. Deformation faults in cold-worked metals. G. B. GREENOUGH AND E. M. SMITH. Note in *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 1, 51–2 (*Jan.*, 1955).

A detailed study of X-ray results on filings of Cu and Al 8% Ag shows that stacking faults are probably present in both. The numerical estimate is of one fault per 600 (111) planes in Cu, and a similar number

in the Al–Ag alloy, though in the latter it is necessary to presume that there has also been a change of lattice parameter. It is suggested this may be due to a decrease in the degree of coherency between the precipitate of $AlAg_2$ and the Al matrix. W. M. LOMER

548.7

3269. Physical defects in silver halides. C. R. BERRY. *Phys. Rev.*, **97**, *No.* 3, 676–9 (*Feb.* 1, 1955).

The concentrations of imperfections in silver halides grown from the melt were investigated by comparing the measured densities with the ideal densities computed from the lattice dimensions. The density defect of the most perfect specimen of silver bromide was $\Delta\rho/\rho = -0{\cdot}8\times10^{-4}$ The greatest amount of imperfection was $\Delta\rho/\rho = -18\times10^{-4}$ in a specimen of silver bromide containing about 4 mole per cent silver iodide. Considering the effects of various configurations of voids, it seems reasonable to attribute most of the density defect in the best crystals to immobile aggregates of vacancies and to dislocations associated with small-angle mosaic structure. The contributions of large-angle grain boundaries and Schottky defects are negligible. A.

548.7

3270. Lamellar defects in single crystals of silicon. J. FRANKS, G. A. GEACH AND A. T. CHURCHMAN. *Proc. Phys. Soc.* [*London*] *B*, **68**, *Pt* 2, 111–12 (*Feb.*, 1955).

Otherwise perfect single crystals of silicon have been shown to contain lamellar defects lying on (111) and (123) planes. Similar lamellae may be introduced by plastic deformation. A.

548.7 : 537.312.5

Capacitance and conductance effects in photoconducting alkali halide crystals. *See Abstr.* 2766

548.7 : 539.4.016.3

Quenching-in of lattice vacancies in pure gold. *See Abstr.* 3195

548.7

3271. On the *V*-centers in alkali iodide crystals. Y. UCHIDA AND Y. NAKAI. *J. Phys. Soc. Japan*, **9**, *No.* 6, 928–34 (*Nov.–Dec.*, 1954).

The properties of *V*-centres were investigated in the alkali iodide crystals (KI and NaI) containing excess iodine. In KI, the absorption spectrum was similar to that obtained by Mollwo, but there was some difference in detail. It was pointed out that the *V*-band in KI can be understood as superposition of three bell-shaped bands I, II and III. Of these, both bands I and II can be safely assigned to the V_2-band. As for band III, however, explanation is not possible at present though it seems to have a fairly close relation to the other two bands. Some proposals were made in regard to the mechanism of colouring with the pointed electrode and the explanation of the doublet structure of the V_2-band in KI. A.

548.7

3272. *F* centers in pure and hydride-containing alkali halide crystals. R. S. ALGER AND R. D. JORDAN. *Phys. Rev.*, **97**, *No.* 2, 277–87 (*Jan.* 15, 1955).

Additional evidence regarding the role of imperfections in the γ-ray colouring and optical bleaching of the alkali halides has been obtained by comparing crystals with and without *U*-centres. Parameters varied were γ-ray exposure rate, crystal temperature, hydride concentration, *F*-band illumination intensity and thermal history of the crystal. The colouring efficiency increased with temperature, trap depth and vacancy or *U*-centre concentration. Under *F*-band illumination, both pure and *U*-centred crystals exhibited an initial period of rapid bleaching, followed by a long slow-bleaching period. Interrupting the bleaching in *U*-centred crystals by storage in the dark restored the higher bleaching rate. The slow bleaching was temperature-dependent, increased slightly with *F*-band illumination intensity and was essentially independent of the *U*-centre concentration. The results support the hypothesis that colouring and bleaching rates are primarily controlled by the availability of suitable holes and vacancies. Crystals containing the hydride colour more efficiently than pure crystals because all constituents of the *F*-centre are present in the parent *U*-centre; whereas pure crystals bleach faster because of the accessibility of the holes. A.

548.7 : 535.345

Formation of colour centres in $NaNO_3$ exposed to ionizing radiation. *See Abstr.* 2615

548.73/.74

X-ray and electron investigation of materials. *See also under* "Structure of solids." Decimal classification 539.26/.27

548.73

3273. Paracrystalline structures. R. HOSEMANN. *Naturwissenschaften*, **41**, *No.* 19, 440–6 (1954) In German.

A number of two-dimensional gratings and their optical diffraction patterns are reproduced. These simulate the X-ray diffraction patterns of crystals with imperfections such as thermal motion, distortion or slow wandering from periodicity in one dimension or in two. Comparisons are drawn between some of the patterns and observed patterns of polyurethan, collagen, α-keratin and liquids; fair agreement is obtained. A. R. STOKES

548.733

3274. A high-temperature X-ray camera. J. R. JOHNSON. *J. Amer. Ceram. Soc.*, **37**, *No.* 8, 360–2 (*Aug.*, 1954).

The specimen is heated by a simple tantalum resistance heater and a sliding film holder permits a number of successive pictures to be taken without disturbing the apparatus. The camera will operate up to 2200°C.

SCIENTIFIC INSTRUMENT RESEARCH ASSOC.

548.733

3275. A new point-focusing monochromator. D. W. BERREMAN, J. W. M. DUMOND AND P. E. MARMIER. Letter in *Rev. sci. Instrum.*, **25**, *No.* 12, 1219–20 (*Dec.*, 1954).

A method is described of cutting and bending a lamina from a single crystal of quartz so as to give a surface of cylindrical form, with the crystal planes cylindrically curved in a plane at right angles. The smallest point focus obtained with it is a few tenths of a millimeter. With an aperture of 0·25 mm, fourth-order diffractions from collagen were recorded in less

than 2 hr exposure, compared with ~100 hr with the two-crystal monochromator previously used [Shenfil, Abstr. 7312 (1952)]. V. E. COSSLETT

548.733

3276. The quantitative evaluation of photographic X-ray diffraction patterns by means of a converter. J. C. M. BRENTANO. *J. photogr. Sci.*, **2**, *No.* 5, 150–3 (*Sept.–Oct.*, 1954).

Discusses the quantitative evaluation of patterns with steep density gradients by means of a convertor coupled to a microdensitometer so as to yield tracings on which the ordinates are directly proportional to exposure or intensity values. Use is made of a standard transmission-exposure convertor curve and the development of the method is particularly directed towards establishing a definite correlation between points of the convertor curve and the corresponding transmission values on the photographic pattern. A.

548.733

3277. A servo-controlled microdensitometer for X-ray diffraction photographs. J. R. BROWN, H. K. MONEYPENNY AND R. J. WAKELIN. *J. sci. Instrum.*, **32**, *No.* 2, 55–9 (*Feb.*, 1955).

The instrument is designed primarily for measuring densities and positions of lines on Debye–Scherrer photographs. The split beam principle is used, light passing through the film being compared with that transmitted by a linear density wedge. The measuring system consists of two photocells in a bridge circuit, controlling a servomechanism which automatically moves the wedge to the balance position. The density is indicated directly by a revolution counter. The accuracy is 0·004 units up to density 3. A.

548.734

3278. X-ray precession techniques. D. J. FISHER. *Amer. Mineralogist*, **37**, 1036–54 (1952).

Methods are given for obtaining orientation photographs of single crystal with the precession camera.

SCIENTIFIC INSTRUMENT RESEARCH ASSOC.

548.734

3279. The anomalous X-ray transmission in calcite. II. Investigations in the wavelength range 558 X.U.–1932 X.U. G. BROGREN AND Ö. ADELL. *Ark. Fys.*, **8**, *Paper* 40, 401–26 (1954).

The previously [Abstr. 2313 (1955)] developed theoretical treatment of the anomalous X-ray transmission through perfect absorbing crystals in the region near the Bragg angle has been checked experimentally with calcite crystals in a double crystal spectrometer. With the monochromator crystal cut for symmetric Bragg reflection the transmission through three analyser crystals has been investigated in the wavelength range 558–1932 X.U. The analyser crystals were cut for symmetric Laue reflection. The transmission was also studied with a monochromator crystal cut for symmetric Laue reflection. The theoretical shapes of the intensity curves of the transmitted and reflected beams have been calculated and compared with the experimentally obtained patterns. A very satisfactory agreement between theory and experiment was obtained. It was also possible to verify the theoretically predicted asymmetry of the Bragg diffraction pattern for a perfect absorbing crystal. A.

548.734

3280. Integrated intensities of the diffracted and transmitted X-rays due to ideally perfect crystal (Laue case). N. KATO. *J. Phys. Soc. Japan*, **10**, *No.* 1, 46–55 (*Jan.*, 1955).

The analytical expressions of the integrated reflecting power and transmitting power of X-rays for absorbing perfect crystals are obtained as follows: the diffracted wave, $R_H^y = e^{-\mu_0 t} \cdot \frac{\pi}{2}\left[2\sum_{n=0}^{\infty} J_{2n+1}(2A) + I_0(h) - 1\right]$, the transmitted wave, $R_T^y = e^{-\mu_0 t} \cdot (-2\pi)\left[\sum_{m=1}^{\infty} m \cos m\beta I_m(h)\right] - R_H^y$. In these formulae $h = 2A\sqrt{k^2+g^2}$ and $\beta = \tan^{-1} k/g$. J_m is a first-kind Bessel function of mth order and I_m is a modified Bessel function of mth order and the other notations are the same as those of Zachariasen's textbook on X-ray diffraction (1944). A practical method of obtaining the numerical values of R_H and R_T^y, and calculated results are shown. A.

548.735.44

3281. The use of a high-speed digital computer for the direct determination of crystal structures. I. W. COCHRAN AND A. S. DOUGLAS. *Proc. Roy. Soc. A*, **227**, 486–500 (*Feb.* 8, 1955).

A method is described whereby an electronic computer, the EDSAC, may be used to select a set, or sets, of signs for the coefficients $F(\mathbf{h})$ of a Fourier series, such that the Fourier series satisfies a certain condition. This condition is expressed as $\chi \equiv \sum_{\mathbf{h}}\sum_{\mathbf{h}'} P(\mathbf{h},\mathbf{h}')S(\mathbf{h})S(\mathbf{h}')S(\mathbf{h}+\mathbf{h}') \geqslant \chi_0$, where $S(\mathbf{h})$ denotes the sign of $F(\mathbf{h})$ and $P(\mathbf{h},\mathbf{h}')$ is a weighting factor related to the probability that $S(\mathbf{h})S(\mathbf{h}') = S(\mathbf{h}+\mathbf{h}')$. In certain circumstances the determination of a crystal structure which is beyond the range of other direct methods is possible by this procedure. A.

548.736 : 545.824

3282. Standard X-ray diffraction powder patterns. III. Data for 34 inorganic substances. H. E. SWANSON, R. K. FUYAT AND G. M. UGRINIC. *Circ. Nat. Bur. Stand., No.* 539, 73 *pp.* (1954).

For Pt II, see Abstr. 11523 (1954). Patterns are presented in revision of the eighty-one corresponding patterns in the A.S.T.M. card file; patterns for two compounds not represented in the file are also included. A.

548.736.1

3283. A precision determination of the lattice constant of silver by the back-reflection method. G. BECHERER AND R. IFLAND. Note in *Naturwissenschaften*, **41**, *No.* 20, 471 (1954) In German.

By means of a thermostatically controlled back-reflection camera the lattice constant is found, in terms of the Co$K\alpha_1$ wavelength, to be 4·07724 ± 0·00004 Å at 20°C. [It would appear that the unit should be kX, since Erikson's (1928) value of wavelength, 1·785287 Å is used.] A. R. STOKES

548.736.1

3284. The structure of the amorphous phase of semimetals. H. KREBS AND F. SCHULTZE-GEBHARDT. Note in *Naturwissenschaften*, **41**, *No.* 20, 474–5 (1954) In German.

An optical device [Abstr. 8074 (1953)] was used to

give radial distribution curves of atoms in amorphous Sb, As and Se. The curve for Sb is reproduced and is interpreted in terms of small collections of atoms arranged in double layers. A. R. STOKES

548.736.3

3285. Different ice forms under ordinary conditions. R. M. VANDERBERG AND J. W. ELLIS. Letter in *J. chem. Phys.*, **22**, *No.* 12, 2088 (*Dec.*, 1954).

Newly prepared single ice crystals showed interference and absorption spectra which differed from those of older crystals. Other new crystals showed a third spectrum which did not change in several months. The differences consist of changes in band structure near 2·0 μ and are probably associated with the hydrogen bridges between the water molecules.

A. J. TAYLOR

548.736.4

3286. X-ray studies on the structures of solid solutions NaCl–$CaCl_2$. I. Main results and general considerations. S. MIYAKE AND K. SUZUKI. *J. Phys. Soc. Japan*, **9**, *No.* 5, 702–12 (*Sept.–Oct.*, 1954).

Stationary X-ray diffraction patterns from transparent single crystals of solid solutions of NaCl dissolved with a few per cent of $CaCl_2$ show a number of diffuse spots. Their displacements with the change of the direction of incident X-rays reveal the existence of several kinds of rods in reciprocal space. Among them, the rods running along ⟨111⟩ and ⟨310⟩ rows are most remarkable. The appearance of these rods is considered as the result of the formation of thin plate-like precipitates in the matrix because of the homogeneous solid solutions being unstable at room temperatures. The precipitates may be the places where Ca^{++} ions replacing Na^{+} ions, and vacancies of Na^{+} sites, are locally concentrated. It was shown that the plate-like precipitate responsible for ⟨111⟩ or ⟨310⟩ rods is probably composed of an assembly of anti-phase domains of superstructures. A.

548.736.4

3287. The structure and properties of some ternary alloys of manganese, zinc and carbon. R. G. BUTTERS AND H. P. MYERS. *Phil. Mag.*, **46**, 132–43 (*Feb.*, 1955).

Single phase ternary alloys of Mn, Zn and C have been prepared. These alloys have an ordered structure of the perovskite type and show a spontaneous magnetization at room temperature. The observed magnetic properties are exceptional and indicate a new type of ferrimagnetic behaviour postulated by Néel but hitherto unobserved in experiment. A.

548.736.4

3288. The measurement of electron transfer by X-ray diffraction methods. P. J. BLACK. *Phil. Mag.*, **46**, 155–63 (*Feb.*, 1955).

In the course of structural analyses of aluminium–transition metal compounds, attempts have been made to find evidence for electron transfer effects proposed by Raynor. The results obtained are ambiguous if the intensities have not been measured on an absolute scale. Previous interpretations based on $(F_0 - F_c)$ syntheses must be revised because deficiencies in the *f*-curves used in the calculations have been revealed. It is also shown that the effects of overlap, series-termination and limited counting area can alter appreciably the electron counts on F_0 syntheses. The ultimate possibility of detecting transfer is considered. A

548.737

3289. The structure of some proteins as revealed by an X-ray scattering method. U. W. ARNDT AND D. P. RILEY. *Phil. Trans A*, **247**, *No.* 932, 409–39 (1954).

548.74

3290. Measurements of electron diffraction intensities by means of Geiger counters. Experimental determination of relative values of the atomic factor for gold, silver and aluminium. S. LENNANDER. *Ark. Fys.*, **8**, *Paper* 54, 551–613 (1954).

An electron diffraction apparatus has been constructed for intensity measurements with Geiger counters. This method of registration provides more accurate intensity curves than the photographic method hitherto in use, while at the same time considerable time is gained. Self-supporting metal foils of down to 75 Å mean thickness were prepared, such that the microcrystals in the foils have no tendency to preferred orientation—or only a negligible one. Satisfactory results were obtained with Au and Ag, but the Al foils all exhibited a certain tendency to such preferred orientation, and an approximate scheme of corrections was worked out for Al foils with partial (111) orientation, for use in the experimental determination of the atomic factor. Relative diffraction pattern intensities were measured for Au (30·0 kV, 90–225 Å; 18·0 kV, 110 Å), Ag (29·5 kV, 75–250 Å) and Al (27·0 kV, 140–410 Å), and from these the atomic factors determined. The atomic factor curve obtained is in each case less steep than that predicted by the kinematic theory. The deviation from the theory is greatest for Au. Foil thickness was not found to have any distinct effect on these results. The half-width of the (200) ring was found to be larger than those of the neighbouring rings. There is a general increase of the half-width with the scattering angle. The mean size of the microcrystals in the foils was, on an average, 55 Å for the Au foils, 60 Å for Ag and 110 Å for Al. The intensity distribution of the background was investigated for all foils, over a range extending in most cases from the (111) to the (511) ring. The contrast between the diffraction rings and the background was determined for the different foils, and is compared with the foil thickness and the crystal size. A.

548.74

3291. Simultaneous reflexion in electron diffraction as a cause of the failure of Friedel's law. K. KOHRA. *J. Phys. Soc. Japan*, **9**, *No.* 5, 690–701 (*Sept.–Oct.*, 1954).

Miyake and Uyeda found that an asymmetry occurs in the intensities of a pair of reflections (*hhl*) and ($hh\bar{l}$) when an electron beam impinges upon a cleavage face (100) of a zinc blende crystal in the [$\bar{1}$10] azimuth, which violates Friedel's law. In the present paper this phenomenon is studied in detail by applying the dynamical theory. Assuming the intensities of only the two reflections (*hhl*) and ($hh\bar{l}$) to be large and neglecting all other reflections, asymmetry is found to occur for an odd index when the selective reflection takes place in the Bragg case, and does not for an even index. By numerical calculation, (331) has

one peak and (33$\bar{1}$) has two peaks, with the integrated intensity of (331) larger than that of (33$\bar{1}$). These results are in accordance with the general trend of experimental observations. Detailed features of experimental observations which are inconsistent with this theory may be explained qualitatively by taking into account the effect of weak reflections or additional simultaneous reflections. The present work proves that Friedel's law fails in dynamical theory. It must be emphasized that the failure is not caused by the effect of absorption or dispersions, but is due to a dynamical interaction between simultaneously excited reflection. A.

548.74

3292. Interference fringes in electron micrographs of magnesium oxide. T. HIBI, K. KAMBE AND G. HONJO. *J. Phys. Soc. Japan*, **10,** *No.* 1, 35–46 (*Jan.*, 1955).

The striations, or so-called equal-thickness fringes, appearing in electron micrographs of magnesium oxide, have been studied in detail. It was found that the spacing of the striations ranges from 50 to several hundred Å, depending on the index of reflection, azimuth and glancing angle. The explanation of the striations is given by the dynamical theory applied to a wedge-shaped crystal. Calculated spacings of the striations as a function of azimuth and glancing angle are compared with observed values, giving fairly good agreement. Some newly found crystal shapes other than cubic and the effect of simultaneous reflections on the striations are also described. A.

548.74

3293. Crystal structure determination by neutron diffraction. R. BRILL. *Z. Elektrochem.*, **58,** *No.* 8, 591–9 (1954) In German.

Compares X-ray and neutron diffraction. Since X-rays are scattered by the atomic electrons and neutrons in general by the nucleus the atomic scattering factors differ. Neutrons distinguish between isotopes; also by neutron diffraction light atoms are no more difficult to locate than heavy ones. The magnetic moment of the neutron makes possible the determination of the orientation of magnetic moments. Examples of these applications are given and attention is drawn to the possibility of the phase determination of structure factors by isotopic substitution.

J. THEWLIS

548.74 : 538.221

Neutron diffraction studies of magnetic structure of alloys of transition elements. *See Abstr.* 2878

GEOPHYSICS 55

55

3294. The international geophysical year, 1957–58. S. CHAPMAN. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 94–9 [see Abstr. 3301 (1955)].

Proposals submitted to the Canberra meeting of the Mixed Commission on the Ionosphere concerning the organization and scope of an intensive world-wide series of geophysical observations over the year 1957–58, this being 25 years since the last (Second) International Polar Year. Observations are no longer to be confined to polar latitudes, and some suggestions for geomagnetic and auroral observations are given.

G. M. BROWN

550.385

3295. The morphology of magnetic storms. S. CHAPMAN. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 84–8 [see Abstr. 3301 (1955)].

Consideration of the departure of a magnetic element from its long-term mean value as a function of latitude and storm time. The method is applicable to the analysis of any scalar geophysical parameter.

G. M. BROWN

550.385 : 551.594.5

3296. Magnetic storms and aurorae. H. ALFVÉN. *University of Maryland, The Institute of Fluid Dynamics and Applied Mathematics. Lecture Series No.* 31 (*Feb.*, 1954) 38 + xi *pp. figs.*

The author describes a modified version of his earlier theory of magnetic storms. This takes account of the inertia of the solar stream particles and leads to an explanation of the initial phase of a storm.

A. T. PRICE

550.9

3297. Age determination of granite from the Fichtelgebirg by the argon method. W. NODDACK AND G. ZEITLER. *Z. Elektrochem.*, **58,** *No.* 8, 643–6 (1954) In German.

As the half-life of radio potassium is known, the potassium–argon ratio in a mineral enables the age of the mineral to be found. A method of measuring the argon is described using absorption on charcoal and a McLeod gauge. Tests were made on sylvine and on the granite and the ages found to be about $1 \cdot 1$ and $2 \cdot 3 \times 10^8$ years respectively. J. M. HOUGH

550.93 : 539.16.08

3298. Low level counting. Key to advances in radiocarbon dating. J. L. KULP. *Nucleonics*, **12,** *No.* 12, 19–21 (*Dec.*, 1954).

A short report of papers presented at the conference held in Andover, Mass., in October, 1954. The basic assumptions, factors governing the accuracy of the method and improved techniques for counting C^{14} are discussed. L. R. SHEPHERD

551.16 : 523.4

3299. Transitions to metallic phases. W. H. RAMSEY. *Occ. Notes Roy. Astron. Soc.*, **3,** 87–95 (*Oct.*, 1954).

A survey is given of recent theories on the internal structure of the Earth and planets. These aim at replacing the old idea of a central core of iron or iron-nickel, formed by the immiscibility of molten iron and silicates (whereby the iron was presumed to have separated under gravity, in the same manner as in an iron furnace), by the assumption of a chemically homogeneous Earth, in which the existence of a core

is attributed to the enormous hydrostatic pressures at great depth. The pressure at the boundary of the core is supposed to destroy partially the molecular structure of the material, so that it becomes dense and metallic. Ramsey's extension of these considerations to other terrestrial planets pointed to compositions similar to that of the Earth, and in Venus towards a small core of metallic olivine. Jupiter and Saturn appear to be roughly of solar composition, and thus to consist mainly of hydrogen, which, however, possesses its familiar non-metallic structure only in the outer layers of these planets. In the deep interior it is the metallic modification which primarily determines the bulk characteristics of the planets (mean density, moment of inertia, etc.). Uranus and Neptune probably consist mainly of water, methane and ammonia. The paper proceeds to a study of the conditions under which a material, ordinarily non-metallic, may become metallic; it deals in detail with the character of metals and non-metals, of the periodic table, phase transitions, hydrogen and helium and metallic ammonium. A. BEER

ATMOSPHERE . METEOROLOGY 551.5

551.508.8

3300. Lag coefficient of bimetal thermometer of chronometric radiosonde. H. MITRA AND M. B. DATTA. *Indian J. Meteorol. Geophys.*, **5**, *No.* 3, 257–61 (*July*, 1954).

The value of the lag coefficient of the bimetal thermometer used in the chronometric radiosonde of the India Meteorological Department when it is exposed at various orientations to air currents with different speeds has been determined experimentally. The order of errors that may be expected due to lag at different pressure levels has also been computed. A.

551.510.535

3301. Mixed Commission on the Ionosphere, International Council of Scientific Unions. Proceedings of the Third Meeting, Canberra, August 24-26, 1952. *Secrétariat Général de l'URSI, 42 Rue des Minimes, Brussels* (1953) 194 *pp.*

For abstracts of some of the papers, see Abstr. 3294–5, 3305–11, 3321–5, 3337 (1955). For contents of the remaining papers, see Abstr. 3136 (1952), 2098–9, 2844, 5235, 7350 (1953), 1887, 1889, 1891, 1910, 2944 (1954), 3302–3, 3326–7 (1955).

551.510.535

3302. An analysis of electron density variations in the F_2-layer after sunset. T. YONEZAWA. *Rep. Ionosphere Res. Japan*, **5**, *No.* 1, 1–12 (1951)

From the analysis of the nocturnal variation in electron density of the F_2-layer above Washington covering over one solar cycle, it is concluded that the rate of disappearance of electrons at night follows a linear law rather than a quadratic one. Data at Kokubunji have been analysed, taking temperature variations into account and assuming a linear law, i.e. on the basis of attachment theory (pure or modified by Bates and Massey). It has been found that the nocturnal variation of electron density in the F_2-layer is more satisfactorily explained by the present theory than by assuming recombination, and more plausible temperature variations of the upper atmosphere have been obtained. But these variations are not satisfactory enough in winter and suggest that some factors other than here considered will improve the results. [See also Abstr. 3301 (1955).] A.

551.510.535

3303. Intense sporadic-E near the magnetic equator and at the auroral zone. S. MATSUSHITA. Note in *Rep. Ionosphere Res. Japan*, **6**, *No.* 2, 118–19 (1952).

During the day-time there is a narrow intense E_s zone near the magnetic equator which may be related to the eastward intense electric current flow producing the daily magnetic variation. During the night intense E_s occurs in the auroral zone, probably due to solar corpuscles. [See also Abstr. 3301 (1955).] G. M. BROWN

551.510.535

3304. The effect of the magnetic equator on sporadic E ionization. K. RAWER. *C.R. Acad. Sci.* [*Paris*] **237**, 1102–4 (*Nov.* 2, 1953) In French.

E_s data from equatorial stations have been studied. Analysis shows that the marked maximum in E_s ionization at the magnetic equator, first reported by Matsushita [preceding abstract] exists only during the day and only for the ionized clouds characteristic of that layer. The effect is not found for that part of the E_s layer represented in the published data by fbE_s. W. J. G. BEYNON

551.510.535

3305. Recent laboratory measurements of recombination coefficients and the problem of ionospheric recombination. H. S. W. MASSEY. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 20–32 [see Abstr. 3301 (1955)].

Microwave techniques have shown that dissociative recombination probably plays a major role in the decay of electron density in a discharge afterglow [see Abstr. 293 (1953)]. In the discussion following, Appleton reported some measurements of effective recombination coefficient α for the E and $F1$ layers which indicated that α increases when the solar zenith distance increases. Ratcliffe estimated that α decreases with increase in height for night-time conditions in $F2$. G. M. BROWN

551.510.535

3306. Region $F2$ anomalies. E. V. APPLETON. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 63–70 [see Abstr. 3301 (1955)].

Brief account supplemented by discussion at the meeting. Points touched on include: the existence of an annual effect in $F2$ ion-density, geomagnetic distortion, different sunspot cycle control in summer and winter, tidal oscillations in midnight $h'F2$, dissipation by recombination or attachment. G. M. BROWN

551.510.535

3307. Note on anomalies of region $F2$ and on ionospheric storms. K. RAWER. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 145–53 [see Abstr. 3301 (1955)].

Considering world-wide characteristics for $F2$ ionization, the influence of solar activity is well

marked. The variation of the factor (M3000) $F2$ is taken as an index of altitude of the layer, and this shows a geomagnetic influence, and correlates with sunspot number. Some results for individual stations are also mentioned. The effect of magnetic storms on $F2$ ionization appears to be different in summer and winter. G. M. BROWN

551.510.535

3308. The distribution of $F2$ region ionization at high latitudes. J. C. W. SCOTT. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 159–67 [see Abstr. 3301 (1955)].

Assuming a linear relation between the monthly median f_0F2 and the 12-month running average sunspot number S of the form $f = a + bS$, polar contour charts of a and b are separately considered to analyse the distribution of f_0F2 in the Arctic. By taking the deviations at a fixed hour from the average graph obtained for a given month over all longitudes solar and geographical effects are separated. G. M. BROWN

551.510.535

3309. Regional anomalies in f_0F2 of the ionosphere. Y. AONO. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 167–73 [see Abstr. 3301 (1955)].

The ratio of the noon monthly median values of f_0F2 to the highest monthly median value throughout the world for the same month are averaged over 4 years for each station and plotted on geomagnetic co-ordinates to give world-wide distribution maps. Examples are given for various seasons and the features of "mountains" (ratio $> 0{\cdot}9$) and "valleys" (ratio small) discussed. G. M. BROWN

551.510.535

3310. Observation of the Z-component in middle latitudes. H. G. MÖLLER. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 153–9 [see Abstr. 3301 (1955)] In German.

The angle at which the Z-component strikes the earth is measured. $h't$-diagrams obtained at or just below the critical frequency of the Z-component are shown. As the Z-component is reflected from a small angular range only, the diagrams give new suggestions for the fine structure of the ionosphere. A.

551.510.535

3311. Typical scattering processes of radiofrequency waves by electron clouds of the sporadic E layer studied by means of a variable-frequency echo-recording receiver. W. BECKER. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 186–93 [see Abstr. 3301 (1955) In German.

The various types of scattering phenomena at *Es* clouds discussed by Eckersley [*J. Instn Elect. Engrs*, **86**, 548 (1940)] are considered and typical $h'f$ records are given illustrating these. G. M. BROWN

551.510.535

3312. A theoretical investigation of the ionospheric electron density variation during a solar eclipse. O. E. H. RYDBECK AND H. WILHELMSSON. *Chalmers Tekn. Högsk. Handl., No.* 149, 22 *pp.* (1954).

Assuming a uniformly radiating sun, practical formulae are developed for the minimum electron density, as a function of the magnitude of the eclipse, and time of the minimum, allowing for the different apparent diameters of sun and moon (excluding ring-shaped eclipses). The variation of electron density with time through the eclipse is plotted (*a*) assuming constant solar altitude, and (*b*) allowing for its variation during the eclipse. G. M. BROWN

551.510.535

3313. Ionospheric height measurement by the method of delayed coincidence. H. RAKSHIT AND S. D. CHATTERJEE. Note in *Naturwissenschaften*, **41**, *No.* 17, 401–2 (1954).

Block schematic and short description (without detailed circuitry) of method of measuring ionospheric echo heights, claimed to be accurate to $\pm 0{\cdot}1$ km. A scanning pulse of variable delay with respect to the transmitted pulse is used in conjunction with a precision calibrated potentiometer and made to coincide in turn with the ground pulse and echo. G. M. BROWN

551.510.535

3314. Intermediate layers of ionisation between the E and F_1 layers of the ionosphere over Ahmedabad (23°N, 72°·6 E). R. G. RASTOGI. *Proc. Indian Acad. Sci. A*, **40**, *No.* 4, 158–66 (*Oct.*, 1954).

Between the main layers E and F_1 of the ionosphere over Ahmedabad, two intermediate layers occur regularly having virtual heights of 125 and 140 km. They also show the characteristic magneto-ionic splitting. The critical frequencies of these layers follow the position of the sun according to the law $f_0 = k \cos^n Z$, n being about $0{\cdot}38$. Minimum virtual heights of these layers have been shown to be very misleading due to the proximity of the lower layers. The true height and the thickness have been determined for some cases. The true heights of these layers correspond well with the heights of ionization maxima in the ionosphere determined with the aid of rockets. A.

551.510.535

3315. A continuous radio wave method of studying travelling disturbances in the ionosphere. B. RAMACHANDRA RAO AND E. BHAGIRATHA RAO. *J. sci. indust. Res.*, **13A**, *No.* 10, 462–6 (*Oct.*, 1954).

C.W. transmissions on $7{\cdot}210$ and $7{\cdot}150$ Mc/s from the Calcutta and Dacca stations were recorded at Waltair. The three sites were roughly on a NE straight line. The recorded signals were first hops, and as the transmitters were spaced 240 km apart, the reflection points were spaced by 120 km. The movement of an ionospheric disturbance from Calcutta to Dacca affects each record in turn, the time interval giving a measure of the velocity component. Records were taken daily from 1200–1300 and 1700–1800 IST. The afternoon records showed few movements; these were attributed to the sporadic E-layer. The $F2$-layer gave many pairs of disturbances in the evening records. All the disturbances but one moved from Calcutta to Dacca, and most of the velocity components were between 9–20 km/min. A three-transmitter method is under development. W. T. BLACKBAND

551.510.535

3316. The anomalous equatorial belt in the F_2-layer. E. V. APPLETON. Note in *J. atmos. terrest. Phys.*, **5**, *No.* 5–6, 348–51 (*Nov.*, 1954).

An examination of the maximum electron intensity

N_m of the $F2$-layer with time at various magnetic latitudes has shown anomalous effects in an equatorial belt about 4000 km wide. In early morning N_m is a maximum at the equator, decreasing steadily with latitude on either side. As noon approaches a "trough" of relatively low N_m occurs on the equator with "peaks" of N_m at 15–20° latitude N–S. In the late evening this trough is replaced by a crest which disappears rapidly after midnight. The trough and crest are explained as the results of the vertical expansion and contraction of the $F2$-layer.

W. T. BLACKBAND

551.510.535

3317. Determination of electron densities in the ionosphere from experimental (h', f_s) curves. H. A. WHALE. Note in *J. atmos. terrest. Phys.*, **5**, *No.* 5–6, 351 (*Nov.*, 1954).

An error in the argument used as the basis of a previous paper [Abstr. 6636 (1951)] has been found. However, as the predictions are physically acceptable, it is possible that a vigorous argument could be developed. W. T. BLACKBAND

551.510.535

3318. Preliminary results of ionospheric observations of the eclipse of the sun on 30 June 1954. K. BIBL AND F. DELOBEAU. *C.R. Acad. Sci.* [*Paris*] **239**, *No.* 23, 1658–60 (*Dec.* 8, 1954) In French.

Observations within the zone of totality for a spot-free sun. The minimum ionization of the E, $F1$, $F2$ and Es layers showed a positive delay on the optical eclipse maximum. Attempts are made to derive the law of electron dissipation and values of the recombination coeff. G. M. BROWN

551.510.535

3319. Influence of the inclination of the terrestrial magnetic field on the absorption of radio waves in the D layer. P. LEJAY AND D. LEPECHINSKY. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 2, 136–8 (*Jan.* 10, 1955) In French.

A general expression for the absorption coeff. K is given which includes the angle between the direction of propagation and the earth's magnetic field. It is shown that for the D-layer the ordinary and extraordinary ray values of K change in opposite senses with increase of this angle, and that a cosine law is not directly applicable. G. M. BROWN

551.510.535

3320. Lunar tides in the ionospheric F_2-layer above Dakar. F. DELOBEAU. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 2, 222–4 (*Jan.* 10, 1955) In French.

Hourly measurements of f_0 and h' have been analysed by the method of Chapman and Bartels for the period 1 Jan. 1950 to 31 Dec. 1953. Both seasonal and semi-diurnal effects have been found with the lunar tide having its maximum effect in winter of $\pm 0{\cdot}2$ Mc/s and ± 5 km. The seasonal effect is more complex and during the summer there is a diurnal component of greater magnitude than the tidal component. J. M. HOUGH

551.510.535

Radio-wave propagation in the ionosphere. *See also under* "Electromagnetic waves and oscillations." Decimal classification 538.566.3

551.510.535 : 523.72

3321. The Doppler displacement of the ionospheric hydrogen lines and its bearing on the auroral theory and solar terrestrial relationships. L. VEGARD. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 135–44 [see Abstr. 3301 (1955)].

Summary paper dealing with the formation, constitution and atmospheric absorption of solar ray bundles, and the detection, intensity variations and Doppler displacement of H showers in the atmosphere. G. M. BROWN

551.510.535 : 523.78

3322. Ionospheric measurements at Khartoum during the total eclipse on 25 February, 1952. C. M. MINNIS. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 38–42 [see Abstr. 3301 (1955)].

Results for the E-region as Abstr. 584 (1953). No changes were found in f_0F2 or of height or thickness of the $F2$ layer which could be attributed to the eclipse. There was, however, a pronounced eclipse effect in the lower part of $F2$, below 300 km, suggesting that $F2$ consists of a solar-controlled lower region and largely solar-independent upper region. D-region absorption appeared to fall markedly near totality with a time lag of only 6 min. G. M. BROWN

551.510.535 : 523.78

3323. Ionospheric measurements at Ibadan, Nigeria during the eclipse of the sun, February 25, 1952. W. R. PIGGOTT. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 42–50 [see Abstr. 3301 (1955)].

Results of automatic $h'f$ and manual absorption measurements. The maximum phase of the eclipse (75%) occurred about 2 hours after sunrise when the ionosphere was normally undergoing rapid changes. A new low $F2$ layer appeared to be formed below the normal one. Results for the E layer could be explained by assuming ionizing radiation from several intense local sources on the west limb of the sun in addition to that from a uniform solar disk. G. M. BROWN

551.510.535 : 523.78

3324. Ionospheric observations made by the Swedish solar eclipse expedition to Italy on February 25, 1952. O. F. PERERS. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 50–62 [see Abstr. 3301 (1955)].

Account of observations made at Naples where the optical eclipse was only 30%. Visual as well as panoramic recording was used. The maximum reduction of E-layer ionizing radiation (26%) was somewhat greater than theoretical values assuming a uniformly radiating sun. It can be explained by assuming that on the eclipse day 87% of the ionizing radiation came from the innermost corona and 13% from the prominence areas. Data for the $F1$ layer indicated similar trends, while the behaviour of the $F2$ layer appeared anomalous. G. M. BROWN

551.510.535 : 537.311.37

3325. The electrical conductivity of the ionosphere. T. G. COWLING. *Proc. Mixed Commission on the Ionosphere, Canberra* (1952) 106–9 [see Abstr. 3301 (1955)].

Assuming that the ionospheric conductivity currents

flow mainly in the *E* layer, the integrated conductivity can be calculated. Former calculations have indicated a value less than that estimated from Chapman's dynamo theory of lunar geomagnetic variations by a factor of about 100. Allowance for that part of the current-flow which is not impeded by the magnetic field, and also for the partial polarization which occurs, reduces the discrepancy to a factor of about 5, but does not entirely remove it. G. M. BROWN

551.510.535 : 537.311.37

3326. A suggestion for the electric conductivity of the upper atmosphere from an analysis of diurnal variations of terrestrial magnetism. II. M. HASEGAWA AND H. MAEDA. *Rep. Ionosphere Res. Japan*, **5**, *No.* 4, 167–78 (1951).

For Pt I, see Abstr. 6651 (1951); see also Abstr. 3301 (1955).

Observed diurnal variations of geomagnetism S_q are analysed into diurnal variations of electric field and those of electric conductivity of the upper atmosphere by means of methods of approximate calculation. It is noticed that the semidiurnal variation in the analysed electric field is remarkably small compared with that in S_q. The most important suggestion from results of calculation is that the amplitude of diurnal variation of conductivity in the N–S direction is very likely greater than that in the E–W direction. This may add a new condition for determining the electrical states of the upper atmosphere. A.

551.510.535 : 537.311.37

3327. A suggestion for the electric conductivity of the upper atmosphere from an analysis of diurnal variations of terrestrial magnetism. II. (Supplement). H. MAEDA. *Rep. Ionosphere Res. Japan*, **6**, *No.* 3, 155–8 (1952).

The results of the previous paper are somewhat questionable quantitatively, because of the scattering of calculated values. A further approximate calculation confirms that: (i) the formulae of diurnal variation of conductivity proposed in the preceding paper are effective in lower latitudes, and its directional inequality decreases with latitude; (ii) the 3rd harmonic term of diurnal variation of conductivity may be so small that it can be neglected. A.

551.510.535 : 621.396.11

3328. A theoretical and experimental study of the recombination coefficient in the lower ionosphere. A. P. MITRA AND R. E. JONES. *Trans Inst. Radio Engrs Prof. Group on Antennas and Propagation*, **AP-2**, *No.* 3, 99–102 (*July*, 1954).

The experimental study involves analysis of new experimental data such as 150 kc/s radiowave absorption, polarization, and phase heights; absorption of short-wave galactic radiation; and *E*-region critical frequency, as well as recombination values already published. Then, by use of the theories of dissociative recombination and negative ions, a theoretical model is derived which is consistent with the experimental results. The values of the coefficient during night-time and during sudden ionospheric disturbances are discussed. A.

551.521

3329. Theoretical verification of the logarithmic formula for the relative net radiation to a cloudless sky. O. LÖNNQVIST. *Ark. Geofys*, **2**, *Paper* 8, 151–9 (1954).

The difficulties of both theoretical and empirical formulae in obtaining the effective radiation and the assumptions made and limitations of earlier formulae are discussed. A formula is given for an isothermal atmosphere at 20°C for the effective radiation $r = 57 - 10 \ln \frac{u + 0{\cdot}014}{1 + 0{\cdot}0034u}$ where u is the vertical optical depth of water vapour, in mm, corrected for the pressure dependence of the absorption coefficients of water vapour. The correction term for other temperatures is given. The stratification term cannot be found mathematically but the empirical method given earlier by the author can be used. R. S. READ

551.521

3330. On the second harmonic of the annual variation of solar radiation and an application of its zeros. J. NEUMANN. *Bull. Res. Coun. Israel*, **3**, *No.* 4, 308–11 (*March*, 1954; publ. *June*, 1954).

From Milankovitch's expression for the harmonic coefficients of the annual variation of solar radiation as a function of latitude modifications are made to obtain an expression for the second harmonic. Values of the harmonic constants of the semi-annual wave of solar radiation at successive latitudes from equator to pole in the northern hemisphere are tabulated. The semi-annual wave vanishes along a latitude circle in the middle latitudes of each of the two hemispheres, at $\pm 44°$. The maximum value occurs at the equator. The relation of these zero values to the annual variation of energy transfer to the atmosphere from the oceans and other extensive bodies of water in middle latitudes is discussed. It is shown that the energy transfer from the water surface to the atmosphere is a double wave. R. S. READ

551.521.1 : 535.313.2

3331. The calculation of the distribution of solar energy reflected by a parabolic mirror. F. CABANNES AND A. LE PHAT VINH. *J. Phys. Radium*, **15**, *No.* 12, 817–20 (*Dec.*, 1954) In French.

The intensity distribution is calculated when the sun is on the axis of the parabolic mirror. The sun is assumed to have a uniform brightness and to form an elliptical image in the focal plane for each point of the mirror surface. Integration then yields the final distribution, which is compared with the Gaussian image of the sun. R. W. FISH

551.573 : 532.65

3332. An experimental investigation of the shatter of salt particles on crystallization. J. P. LODGE AND F. BAER. *J. Meteorol.*, **11**, *No.* 5, 420–1 (*Oct.*, 1954).

Bubbles and spray droplets were generated by directing a jet of air on to a solution of brine at the bottom of a glass tube. These were drawn off through a heated portion of the tube and examined for sampling under a microscope. Counts were made according to 8 size groups. It was concluded that the type of shatter proposed by Dessens cannot play any important part in meteorological phenomena. The absence of shatter in particles of the sizes tested is as explained, in agreement with known principles of evaporation and diffusion. R. S. READ

551.577.59

3333. Silver and lead iodides as ice-crystal nuclei. V. J. SCHAEFER. *J. Meteorol.*, **11**, *No.* 5, 417–19 (*Oct.*, 1954).

Tests were made in a closed cloud chamber with controlled conditions on the effectiveness of samples of AgI_2 and PbI_2 as nuclei. When in the form of vapour particles (*a*) they were equally effective, in an atmosphere supersaturated with respect to ice at −5°C, for temperatures below −5°C, (*b*) in an atmosphere supersaturated with respect to water at 5°C, and in which drops fall into a colder region, the AgI_2 particle shifts to an ice crystal at −5°C but for PbI_2 no ice crystal occurs until about −20°C. When supercooled water droplets fall (*a*) on ice crystals or AgI_2 crystals they freeze instantly, but (*b*) on dry glass or very thin PbI_2 crystals they evaporate. A possible reason for the less effective action of PbI_2 crystals is discussed. R. S. READ

551.593.5

3334. Horizontal attenuation of ultraviolet light by the lower atmosphere. W. A. BAUM AND L. DUNKELMAN. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 166–75 (*March*, 1955).

The horizontal attenuation by the air near the ground was determined as a continuous function of wavelength from 2300 to 4600 Å. Measurements were made by means of photographic spectrophotometry on seventy-eight nights during 1949 at Pasadena, California, and also on three nights during 1950 at Washington, D.C. The results are given in the form of a table of attenuation coefficients (km^{-1}) at selected wavelengths and in the form of representative spectral attenuation curves for conditions ranging from fog to exceptionally clear air. Except for weak oxygen absorption bands between 2421 and 2700 Å, the attenuation coefficient was found to vary quite smoothly (though differently) with wavelength on all nights. Air pollutants, though frequently present, were not spectroscopically identified except for sulphur dioxide, which was encountered in measurable concentration in Washington. Ozone concentrations could be estimated from a few spectra obtained in exceptionally clear weather. A.

551.594.221

3335. Upward stepped leaders from the Empire State Building. B. F. J. SCHONLAND AND D. J. MALAN. *J. Franklin Inst.*, **258**, *No.* 4, 271–6 (*Oct.*, 1954).

A new interpretation of the lightning discharge observations made by McEachron and others at the Empire State Building suggests that the polarity of the upward-moving stepped leaders found by them may have been negative, not positive as has been supposed, the current-recording equipment having failed in most cases to record the initial streamer stages of the discharge. A.

551.594.221 : 621.316.98

3336. Very low frequency noise power from the lightning discharge. J. S. BARLOW, G. W. FREY, JR AND J. B. NEWMAN. *J. Franklin Inst.*, **258**, *No.* 3, 187–203 (*Sept.*, 1954).

Following a summary of present knowledge of the lightning-discharge mechanism, the expression of Bruce and Golde for the destruction of the cloud-image dipole by the discharge is derived phenomenologically. The radiation power spectrum of a lightning discharge is calculated for two cases, considering the radiation to arise from (*a*) the destruction of the cloud-image dipole, and (*b*) the channel as a linear aerial. The power spectrum of the waveform of a distant daytime atmospheric (daytime "tweek") characterized by a decrease in both amplitude and instantaneous frequency with time, is obtained, assuming exponential decay of a sinusoidal waveform whose frequency is that of the power-weighted mean frequency. This waveform power spectrum, the transformed results of the (*b*) analysis above (using available experimentally determined propagation data for v.l.f.), and one of Bowe's spectra of distant daytime atmospherics are compared. There is reasonable agreement of the transformed discharge spectrum with the observed "tweek" spectra, despite the approximations of the calculations, the variations among individual discharges, and the interpolation and extrapolation of the propagation data. These results indicate a peak in the power spectra of distant daytime atmospherics at about 10 kc/s in agreement with other "tweek" workers. While the Bruce and Golde expression seems adequate for radiation analysis, a question has been raised concerning its use, except in special cases, for the near field analysis. A.

551.594.5

3337. The "Electro-jets." S. CHAPMAN. *Proc. Mixed Commission on the Ionsphere, Canberra* (1952) 88–91 [see Abstr. 3301 (1955)].

Short note suggesting ways in which the electric currents along the auroral zone may be determined, by measuring time rates of change of the gradients of the magnetic components. G. M. BROWN

551.594.5

3338. Polarization of radio echoes from auroræ. A. G. MCNAMARA AND B. W. CURRIE. *Nature* [*London*] **174**, 1153–4 (*Dec.* 18, 1954).

Account of observations at Saskatoon on 56 Mc/s and 106·5 Mc/s for which the auroral origin of the echoes has been verified. Echo occurrence as a function of polarization ratio (horizontal to vertical), polarization ratio as a function of range, and echo occurrence as a function of range are considered. G. M. BROWN

551.594.6

3339. The wave-forms of the electric field in atmospherics recorded simultaneously by two distant stations. H. NORINDER. *Ark. Geofys.*, **2**, *Paper* 9, 161–95 (1954).

Oscillograms of lightning atmospherics were recorded at two stations 570 km apart. These recorded the electrical intensity, E, rather than dE/dt, as the former gives the simpler waveforms. The positions of the storms were determined from weather maps and d.f. measurements. The storms were at distances of up to 2400 km. The predischarges were shown to have a quasi-periodicity of about 25 kc/s. At distances much less than 50 km the main discharges gave unipolar disturbances, in such cases the capacitative fields predominate. At distances greater than 50 km the disturbances were in general bipolar, being caused

by the radiation field of the discharge. The damped ground-ray theory accounts for the measured effects for distances too short for ionospheric reflections to be important. For greater distances the time intervals between the main discharge and the first five reflections could be accounted for on the simple ray theory. There was some evidence in support of Budden's theory [Abstr. 2863 (1951)]. W. T. BLACKBAND

551.596.1 : 534.23

3340. Air-to-ground sound propagation. P. H. Parkin and W. E. Scholes. *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1021–3 (*Nov.*, 1954).

The attenuation of sound in air, in the vertical direction, has been measured on six occasions using an aircraft flying at various heights over a microphone at ground level. It was found that there was always negligible attenuation at frequencies below 1000 c/s even though the air was turbulent; at higher frequencies the attenuation was found to be of the same order as the Knudsen–Kneser results for attenuation due to molecular absorption. A.

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84

3341. Velocity discrimination and the intensity-time relation. R. H. Brown. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 189–92 (*March*, 1955).

The visual discrimination of velocity is considered in terms of an observer's response to its direction at different speeds. The hypothesis is advanced that the direct perception of motion in a middle range of speeds involves a single sensory event dependent on the intensity-time relation. To test this hypothesis, four subjects discriminated velocity at different speeds for each of eight durations of exposure. The minimal luminance required for correct judgments of direction was measured by the method of limits. The data indicate that velocity discrimination occurs at intermediate speeds when the energy of the stimulating flash is constant ($It = C$). The reciprocity relation does not hold for exposures longer than a critical duration of 0·1 sec. The luminance of the flash tends to be the sole limiting factor on velocity discriminations at longer durations of exposure ($I = K$). Implications of these results are discussed with reference to other experiments. A.

612.843

3342. The arrangement of peri-foveal and para-foveal receptors at low luminance levels. J. M. Otero, M. Aguilar and J. Yunta. *An. Real. Soc. Espan. Fis. Quim.*, **50**(A), *No.* 9–10, 159–68 (*Sept.–Oct.*, 1954) In Spanish.

A method similar to the one previously described was used to investigate the summating properties of the retinae of four observers. Within the limits of the experiment, the integrating power was found to be independent of the (negative) contrast; it increased with retinal eccentricity and on reducing the luminance level of the test-field. R. A. WEALE

612.843.2

3343. Electroretinal photopic sensitivity curves. E. P. Johnson and T. N. Cornsweet. *Nature* [*London*] **174**, 614–15 (*Sept.* 25, 1954).

Dodt's method [*Nature*, **168**, 738 (1951)] was used in a determination of six points of the spectral foveal sensitivity curve in a range between 470–630 mμ. The test-field subtended an angle of 7·5°. The resulting curve is broader than the C.I.E. curve and the authors believe "that Rayleigh scatter contributes to the photopic electroretinogram, as it does to the scotopic, or . . . that neither the employment of night-blind subjects nor the use of flickering stimuli prevents intrusion of a blue-sensitive system, presumably the scotopic, which contributes to the electroretinogram yet fails to show itself during determination of the photopic luminosity curve by the standard procedures." [The intrusion of extrafoveal photopic mechanisms, and the difference in the function of the macular pigment in the two types of experiment provide alternative explanations of the discrepancy between the two curves.] R. A. WEALE

612.843.2

3344. Radial localization of a single stimulus as a function of luminance and duration of exposure. H. W. Leibowitz, N. A. Myers and D. A. Grant. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 76–8 (*Feb.*, 1955).

Accuracy of localization of the radial position of a single stimulus was determined for various luminance-exposure duration combinations. Localization accuracy, provided the stimulus is seen, is independent of luminance and duration, but varies with the radial position of the stimulus. The results are discussed in terms of events critical to localization accuracy and it is concluded that the magnitude of photochemical events in the end organs does not limit localization accuracy for supraliminal stimuli. A.

612.843.22

3345. Some observations on the modulation of the visual sensation by strong alternating magnetic fields. T. F. Zückler. Note in *Naturwissenschaften*, **41**, *No.* 21, 508 (1954) In German.

Human eyes exposed to a magnetic field (H) of 5000 gauss and alternating at 16·6 c/s perceived a sensation of flicker. This disappeared for $300 < H < 1000$ gauss. The effect was observed only in the presence of illumination. As the illumination decreased after sunset, the sensation became more intense, spread from the periphery towards the centre of the visual field, and suddenly disappeared as it became darker. When a lamp was switched on, the flicker disappeared. [Barlow, Kohn, and Walsh, *American Journal of Physiology*, **148**, 372 (1947)] have also made observations on visual sensations aroused by magnetic fields. R. A. WEALE

612.843.31

3346. Spectral response curves and hue discrimination in normal and color-defective subjects. K. Motokawa and K. Isobe. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 79–88 (*Feb.*, 1955).

Spectral response curves of normal and colour-defective subjects were determined with the method of electric stimulation of the eye. The curves of anomalous trichromats consist of four components *R*, *Y*, *G*, and *B*, among which either *R* or *G* is especially weak. The curves of dichromats consist of three components; *R* and *G* are missing in the protanope and the deuteranope respectively. The three kinds of response in the colour-blind are definitely small compared with the corresponding normal responses. The magnitude of response of anomalous trichromats is intermediate between the normal and the colour-blind. Hue discrimination curves were obtained from one and the same subjects under comparable experimental conditions and interpreted in terms of spectral responses. From these experiments it was concluded that the yellow component plays a very important role in hue discrimination of colour-defective subjects, whereas it is not so important for normal hue discrimination. A.

612.843.31

3347. Indication for the existence of at least four basic excitations in color vision. H. von Schelling. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 209–15 (*March*, 1955).

The tristimulus values of the spectrum colours are expressed as linear functions of four normal distributions which have wavelength as abscissa. This separation explains the main facts of dichromatism. It suggests a new colour triangle. One of its vertices has a negative *y* co-ordinate. Pairs of the centre points of the normal distributions are collinear with this blue corner of the elementary colour triangle. For convenience this triangle is transformed to the orthogonal and isoceles shape. Finally a tentative mathematical expression is given for describing the spectrum locus. The results are compared with the trichromatic coefficients of the C.I.E. Standard Observer. A.

612.843.611

3348. On some after-images. A. Biot. *Ann. Soc. Sci. Bruxelles I*, **68**, *No.* 3, 164–6 (1954) In French.

After-images produced by exposing the eye to white light provide a means of determining the state of adaptation of the eye. R. A. WEALE

612.843.613

3349. Quantum theories of the absolute threshold: the influence of retinal position and area. M. H. Pirenne and F. H. C. Marriott. *Optica Acta*, **1**, *No.* 3, 151–5 (*Dec.*, 1954).

Van der Velden and Bouman studied the area-intensity relationship in an attempt to prove their "two-quantum theory" of the visual absolute threshold. The present experiments demonstrate the non-uniformity of the larger retinal areas used by these authors. The variation of sensitivity with retinal position is so large in these areas that it invalidates the attempted proof of the two-quantum theory, while suggesting that the retinal threshold *n* is equal to at least 3 quanta. A.

612.843.613

3350. Absolute threshold conditions for visual perception. M. A. Bouman. *J. Opt. Soc. Amer.*, **45**, *No.* 1, 36–43 (*Jan.*, 1955).

A quantitative approach to an understanding of fluctuating phenomena encountered near the threshold of vision has involved an analysis of frequency of seeing curves. The results of various investigators are discussed with reference to the possibility of an explanation based exclusively on the statistical fluctuations in the stimulating energy. Psychological variability in the conditioning of the subject can account for controversial results. The integrative actions in the visual system measured with the aid of flashes containing two separate small and short stimuli—with variable time and distance apart from each other—were discussed. Various merits of such experiments are put forward. The absolute threshold behaviour with respect to dependences of threshold energy on duration, velocity of moving sources, length and width of line-shaped targets, diameter and size of circular and square targets, was confronted and found in agreement with the two quanta explanation. Objections and modifying suggestions of other investigators on the two quanta concept are discussed. It is concluded that experimental results deny the correctness of such objections or modifications. The brightness impression of the perceived flash under the various conditions decreases with increasing target-size or test area. Suggestions are made as to the mechanisms which account for this effect. Such mechanisms account for deviations from theory at the simultaneous occurrence of large and long test flashes. A.

612.843.613

3351. Threshold sensitivity to light measured with an extraneous ultraviolet source in the visual field. J. C. Ogilvie and J. E. Ryan. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 206–9 (*March*, 1955).

Light thresholds of normal and aphakic subjects, and subjects with implanted synthetic lenses, were measured under conditions of darkness and with extraneous violet (405 mμ) and ultraviolet (365 mμ) sources of equal apparent brightness in the visual field. It was found that the ultraviolet source caused a greater increase in the threshold of the normal eye than did the violet source. The additional increase could not be attributed to stray light, nor to constriction of the pupil. From the results obtained with subjects who had synthetic lenses, it was concluded that fluorescence of the lens of the normal eye would account for the additional increase in threshold produced by the ultraviolet source. A.

612.843.72

3352. Bibliographic survey of the problem of perception of size. L. Ronchi. *Atti Fond. Ronchi*, **9**, *No.* 3, 161–74 (*May–June*, 1954) In Italian.

This paper gives a detailed review of the problem, ranging from Ptolemy and Roger Bacon to the author's own researches. The effects of accommodation, convergence, binocular fusion, contrast surround and other factors are considered. There is a long bibliography. R. A. WEALE

612.843.72

3353. On the limits of the validity of the formula for psychological magnification. L. RONCHI. *Atti Fond. Ronchi*, **9**, *No.* 3, 214–20 (*May–June*, 1954) In Italian.

A description is given of further work on this subject (see preceding abstract). The magnification (I) is measured by two methods as a function of lens–eye distance (d) and lens power (P). The experimental and theoretical data agree for small values of d. Dependence on P was observed only if the observer could relate the image plane to familiar surroundings.

R. A. WEALE

612.843.721

3354. Studies in binocular vision. III. The mechanism of binocular vision. Y. LE GRAND. *Atti Fond. Ronchi*, **9**, *No.* 2, 137–42 (*March–April*, 1954) In French.

For Pt II, see Abstr. 7944 (1954). A critical review of the anatomy of the visual pathways relevant to the understanding of binocular vision. 31 references.

R. A. WEALE

612.858

3355. Paradoxical direction of wave travel along the cochlear partition. G. V. BÉKÉSY. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 137–45 (*Jan.*, 1955).

The cochlear partition of the ear exhibits a strange phenomenon: waves produced by continuous sinusoidal stimulation may travel toward the vibrating source. A mechanical model was constructed which showed the same vibration pattern as the cochlear partition of the ear and the same paradoxical travelling direction. By stimulating various sections of the model it was possible to show how the travelling waves are formed and why their direction of travel is independent of the location of the driving source. This independence makes it clear why an over-all vibration of the bony walls of the capsule during hearing by bone conduction produces the same sensation as the transmission of the vibrations through the stapes. A.

612.858.71

3356. Method of reproduction and the identification of elementary auditory displays. I. POLLACK. *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1060–3 (*Nov.*, 1954).

A psychophysical procedure which combines the salient features of the classical discrimination and identification experiments is described. Improvement in the identification of aspects of elementary auditory displays is associated with the procedure. However, the improvement is only a fraction of that reasonably expected on the basis of a classical differential threshold analysis. A.

612.858.71

3357. Auditory sensitization. J. R. HUGHES. *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1064–70 (*Nov.*, 1954).

This experiment studied the lowering of the absolute auditory threshold that follows low-tone stimulation. Monaural thresholds were determined continuously with a recording audiometer before and after the ear was exposed to a pure tone. The frequency, intensity and duration of both the exposure tones and the test tones were varied. Auditory sensitization was found to be a general effect among seventeen subjects. The magnitude of the effect was investigated intensively with three subjects. Their results demonstrated that sensitization produced by a pure tone is non-specific: a given tone can sensitize the auditory system to a relatively wide range of test frequencies. Conversely, a relatively wide range of exposure frequencies can sensitize the auditory system to a given test tone. This non-specificity is consistent with what is known, through microelectrode studies, about the spread of energy on the basilar membrane and the spread of excitation in the auditory nervous system. Contralateral sensitization effects were found. A.

612.858.71

3358. Anesthesia and hearing. B. S. ROSNER AND G. A. HEISE. Letter in *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1077–8 (*Nov.*, 1954).

Evoked potentials to pure tone bursts were recorded from auditory cortex in cats. Thresholds for various frequencies as measured by this technique increased in a complicated fashion as depth of anesthesia increased. A.

612.858.73

3359. Intensity discrimination thresholds under several psychophysical procedures. I. POLLACK. *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1056–9 (*Nov.*, 1954).

Discrimination thresholds for the detection of a change in the sound level of a tone were obtained under five experimental procedures. These procedures differed primarily in terms of the presence or absence of an objective comparison signal and in terms of the stability of the test conditions under examination. Under comparable conditions, discrimination in the absence of an objective comparison signal is only slightly less acute than in the presence of such a signal. On the other hand, relatively large increments in the detection thresholds are associated with increases in the instability of the testing conditions, especially over long discrimination intervals. The results are examined in terms of molar concepts more pertinent to the listener than to the ear. A.

612.858.73

3360. Channels of reception in pitch discrimination. A. G. PIKLER AND J. D. HARRIS. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 124–31 (*Jan.*, 1955).

Pitch discrimination was studied in 4 normal hearing subjects monaurally, binaurally, and in a variety of other channels of reception. No difference exists in sensitivity between the two normal ears of a subject, nor is there a difference between the sensitivity of the monaural channels and the binaural channel if all are matched for loudness. Also bone conduction was found to yield essentially equal pitch DL's after loudness was matched. All channels, except successive interaural, are equivalent under matched conditions. Successive interaural channels (standard in the right, variable in the left, and vice versa) show some deterioration of sensitivity and some increase in variance which can be attributed to the momentary fluctuations of diplacusis. Similar fluctuations were found also with respect to a channel utilizing a monaural standard and a binaural variable stimulus, the two ears matched in loudness. Under these conditions, furthermore, a third pitch is sensed, a phenomenon the authors term "triplacusis." An interpretation of diplacusis and triplacusis as interaural interactions is suggested. In cases of perceptive hearing loss, however, the channels are not usually

equivalent in pitch discrimination even if matched for loudness. Evidently other principles must be sought for the pathological case. A.

612.858.73

3361. Pitch perception for certain periodic auditory stimuli. W. R. THURLOW AND A. M. SMALL, JR. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 132–7 (*Jan.*, 1955).

Results of experiments performed to determine the pitch characteristics of pulsed tones are reported. For most of the experiments, the pulsed tones were produced by passing brief rectangular pulses through band-pass filters. For a carrier frequency of 1000 c/s pitch corresponded most closely to the rate at which the pulses were presented; no pitch corresponding to the carrier frequency was heard. For a carrier frequency of 5000 c/s both low and high pitches were heard. The pulsed tones were used at low sensation levels, and spectral analysis showed that no low frequency corresponding to the pulse rate was present. Experiments with two pulsed-tone stimuli presented to the same ear showed that additional pitches were produced, depending on the time separation between pulses. An interpretation was suggested in terms of a neutral "sorting out" process. A.

612.858.74

3362. Pitch discrimination, mels, and Kock's contention. S. S. STEVENS. Letter in *J. Acoust. Soc. Amer.*, **26**, *No.* 6, 1075–7 (*Nov.*, 1954).

Recent data on pitch discrimination are shown to agree reasonably well with the values that would be predicted if just noticeable differences for pitch are subjectively equal when measured in mels. The facts relating to diplacusis and the estimation of musical intervals suggest that the difference limen may be expected to vary irregularly with frequency. A further argument is made that Kock's theoretical explanation of pitch discrimination is invalid. A.

612.858.76

3363. The influence of stimulus duration on the pure-tone threshold during recovery from auditory fatigue. J. F. JERGER. *J. Acoust. Soc. Amer.*, **27**, *No.* 1, 121–4 (*Jan.*, 1955).

Comparison of the threshold shifts for 500, 50, and 5 millisecond short tones following a two-minute exposure to thermal noise at an over-all SPL of 110 db re 0·0002 microbar revealed a disturbance of the pre-exposure time-intensity relationship for threshold during the post-exposure period. The pattern of this disturbance was similar to that which has been described by other investigators in the ear with organ-of-Corti-type hearing loss. Thirty seconds after the termination of the noise the pre-exposure intensity differential among these three short tone durations was markedly reduced. As post-exposure time increased, the decline in the degree of temporary hearing loss was accompanied by a gradual return to the pre-exposure time-intensity relationship. A.

615.832.4 : 534.321.9

3364. The energy distribution in the human body with ultrasonic irradiation. W. GÜTTNER. *Acustica*, **4**, *No.* 5, 547–54 (1954) In German.

The absorption of ultrasonics in the essential components of the human body (fat, muscle, bone) is determined and a calculation made of the energy distribution and temperature rise resulting therefrom. It is found that the temperature rise is higher for bone than for other tissue and in this difference lies the significance of ultrasonic therapy. The above measurements permit an accurate estimate of the best frequency for ultrasonic therapy. Calculations show that the frequency of 0·9 Mc/s now in use is best, not only for deep muscle penetration but also for the superficial layers of the bone. A definition is given for the dose to be used in ultrasonic therapy. A.

TECHNIQUE . MATERIALS 62/69

66.067.5

3365. Production and use of high centrifugal fields. J. W. BEAMS. *Science*, **120**, 619–25 (*Oct.* 22, 1954).

Paper read at the Gordon Research Conference on Instrumentation, 1954. Typical experiments in which high centrifugal fields are used, together with some of the techniques employed, are described. The vacuum-type ultracentrifuge and, in more detail, magnetically supported high-speed rotors are discussed and illustrated. S. WEINTROUB

669

3366. Some physical properties of plutonium metal. E. R. JETTE. *J. chem. Phys.*, **23**, *No.* 2, 365–8 (*Feb.*, 1955).

Data on some of the physical properties of plutonium metal are given, including allotropic modifications, crystal structures, transformation temperatures, melting point, densities, expansion coefficients, electrical resistance, and magnetic susceptibility. A.

669.783

3367. Technology of germanium. J. M. MERCIER. *Onde élect.*, **34**, 559–72 (*July*, 1954) *In French.*

The occurrence of germanium in natural ores is stated briefly, and followed by a description of the various methods employed for its extraction and subsequent preparation in a state of optimum quality. The procedure is by reduction of the oxide with hydrogen to the metal, followed by either progressive crystallization or localized fusion (zone melting). The conversion of the polycrystalline to the monocrystalline form is then described. 33 figures and 31 references. H. H. HODGSON

PHOTOGRAPHY 77

77.023.4

3368. A method for rapid development of thick nuclear emulsions using acid amidol. A. BERNET AND R. CHASTEL. Letter in *J. Phys. Radium*, **15**, *No.* 11, 781–2 (*Nov.*, 1954) In French.

Details of the method and a formula for the developer are given. The developing time varies from 25 min for a 50 μ emulsion to 40 min for one of 400 μ thickness. P. ROTHWELL

77.023.7

3369. On the fixing of nuclear emulsions. J. P. LONCHAMP AND H. BRAUN. *J. Phys. Radium*, **15**, *No.* 10, 139 A–144 A (*Oct.*, 1954) In French.

The influence of various factors has been studied: the concentrations of the fixing baths, their chemical compositions, the effect of stirring and the effect of the type of emulsion used. The results show some differences from those obtained with ordinary emulsions. The use of ammonium hyposulphite presents certain advantages, it has been noticed, moreover, that it does not attack the silver grains after development to such an extent as to prohibit its use.

P. ROTHWELL

771.351

3370. A method of assessing objectively the photographic resolving power of a lens. H. T. GOTTFRIED AND N. MURCOTT. *J. Opt. Soc. Amer.*, **45**, *No.* 3, 141–5 (*March*, 1955).

The advantage of objective over visual assessment of Cobb-type resolution test films is discussed. Experiments are described in which an existing microphotometer was used to establish the necessary objective resolution criteria. Following a suggestion in a recent paper by Fellgett, the density fluctuations due to film grain are reduced to a minimum by using a microphotometer slit of the same dimensions as the image of the Cobb bar falling on the slit. The simple objective resolution criteria established are in terms of the contrast between the bars and intervening space of the Cobb unit. The numerical values of the criteria may vary with the type of film used and the conditions of the resolution test. Values are given for the particular film and test conditions used in the experiment. The objective resolution criteria are applied to measurements on a resolution test film, and the resultant objective assessment shows good agreement with the visual "half-Cobb" method assessment. It is suggested that the method could be applied generally and an automatic instrument for the objective assessment of resolution test films devised.

A.

771.5 : 534.39

Effect of ultrasonic energy applied during the after-ripening stage of photographic emulsion preparation. *See Abstr.* 2530

771.534.531.5

3371. An instrument for the accurate measurement of low optical densities. A. S. CROSS. *J. sci. Instrum.*, **32**, *No.* 2, 59–60 (*Feb.*, 1955).

An instrument for the measurement of photographic densities in the range 0 to 0·3 with reproducibility of 0·0001 is described, a greater range being obtainable at the expense of sensitivity. A balanced optical system is employed, modulation of the measuring beam being performed by polarizers. Barrier layer photocells and a galvanometer are used for balance indication.

A.

771.534.55

3372. The relation of definition to sharpness and resolving power in a photographic system. G. C. HIGGINS AND R. N. WOLFE. *J. Opt. Soc. Amer.*, **45**, *No.* 2, 121–9 (*Feb.*, 1955).

Definition, as the term is used in the present paper, is the quality aspect of photographs that is associated with the clarity of detail. Resolving power is used in its customary sense, and sharpness is defined as the impression received by an observer viewing well-resolved elements of detail; its objective correlate is acutance, which has been defined quantitatively elsewhere. A series of negatives was made of a scene, the lens being moved longitudinally between exposures to vary the resolving power and the acutance in the negatives. A corresponding set of negatives was made of resolving power and acutance test objects. Positive transparencies were made from both sets of negatives. The transparencies of the scene were judged for definition, and numerical values were assigned by statistical methods. Neither acutance nor resolving power correlated well with definition except when the resolving power exceeded the limit set by the eye, in which case acutance correlated fairly well. A practical correlate of definition is proposed which consists of acutance multiplied by an exponential function of resolving power.

A.

771.535

3373. The dual mechanism of latent-image formation. E. E. LOENING, E. A. SUTHERNS AND B. P. BOURNE. *J. photogr. Sci.*, **2**, *No.* 5, 160–6 (*Sept.–Oct.*, 1954).

Experimental evidence is presented in support of an hypothesis of a dual mechanism of latent-image formation, such as was suggested in Abstr. 1935 (1954). The time-scale characteristic curves of silver-bromide sols are shown to be composites of two curves if the sols are developed under certain defined conditions; the two curves originate from the two mechanisms of latent-image formation, viz. from a surface complex and from the lattice proper, a "complex" and a "crystal" image being produced. The two mechanisms are shown to possess different spectral sensitivity characteristics. The terms "complex" and "crystal" image are discussed in relation to conventional terms, such as the "surface" and the "internal" image. It is suggested that the dual mechanism of latent-image formation is a general feature not only of sols but also of photographic emulsions.

A.

772

3374. On the effect of two successive illuminations on photographic layers. M. T. VIGÓN AND M. SOLÍS. *Optik*, **11**, *No.* 12, 541–56 (1954) In German.

Two film types were used in experiments to compare the photographic densities achieved by one continuous exposure (time t at intensity I) with those resulting from two consecutive exposures (times t_1 and t_2 at intensities I_1 and I_2) with variable interval between (τ). As an example, if $I_1 = I_2 = I/2$ and $t_1 = t_2 = t/2$ and $\tau = 24$ hr, the characteristic curve is shifted along the log E axis, so that the same total E gives higher S (blackening) for the unbroken exposure. Detailed results are given for the change of blackening ΔS as a function of $R = I_2/(I_1 + I_2)$. The value of ΔS is a max. when $I_1 \simeq I_2$, and also increases with log E, but is independent of R for a given value of E. Brief references are made to the different effects of white, blue, green and red light sources, and to the pre-treatment of the film with KNO_2. The data given refer to the surface image, but

the internal image behaves similarly. The results are discussed in terms of grain sensitivities.

S. T. HENDERSON

778.13

3375. Photographic enlargement and reduction in one dimension only. R. N. BRACEWELL. Letter in *J. sci. Instrum.*, **32**, *No.* 1, 37 (*Jan.*, 1955).

A two-stage photographic technique is described which allows instrument records to be reproduced with a compressed time scale. R. W. FISH

778.31

3376. Flash photomicrography of rat liver sinusoids. B. A. JARRETT. *J. photogr. Sci.*, **2**, *No.* 6, 184–7 (*Nov.–Dec.*, 1954).

An optical system is described which can, for a number of applications, be used in place of the quartz rod method of trans-illuminating organs in an anaesthetized, intact animal for microscopical examination, and photography. It transmits approximately ten times more light than a quartz rod under the same conditions, and gives a conical illuminating beam, allowing considerably higher resolution. These factors permit photography of the organ in greater detail than is possible with the quartz rod technique. A specially designed microscope stage is used. The micro-camera embodies a reflecting single leaf electric shutter and is used in conjunction with a mercury–argon flash tube. The tube has a 3 mm diameter light source rich in the yellow and green wavelengths, and gives an 8 joule flash of 10 μsec duration. A.

778.33

3377. On the autoradiographic method. G. RIEDER. Note in *Naturwissenschaften*, **41**, *No.* 18, 421–2 (1954) In German.

Factors concerning the use of autoradiography are (1) sensitivity and contrast of the emulsion, (2) geometry of the set-up, and (3) statistical fluctuations of the particles emitted. These factors are discussed, and a formula for statistical limitations is evolved.

D. V. MABBS

778.33

3378. Concerning the sharpness from X-ray intensifying sheets. C. KLETT. *Z. angew. Phys.*, **6**, *No.* 12, 556–60 (1954) In German.

A test object (a strip of Pb foil mounted on thin "Plexiglass") is irradiated between X-ray intensifying sheets coated with $CaWO_4$. Plates and microphotometer readings are given. Variations of response with thickness and particle size are measured and discussed. It is shown that, with modern screens, particle size has no influence on definition. Unsharpness in the image arises through: (1) scattering of fluorescent light in the illuminating layer, the smaller the object the greater the effect of the associated circle of unsharpness; (2) hardening of the X-radiation after penetration of the front screen, resulting in a reduction in contrast; this factor is independent of object size. D. V. MABBS

778.33

3379. Intensifying screens for autoradiography. M. AGENO. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 1, 266–8 (*Jan.*, 1955) In Italian.

Autoradiographs taken from chromatograms containing radioactive isotopes, e.g. Sr^{90}, may be intensified by a fluorescent screen between the source of radiation and the emulsion. With screens of tetraphenylbutadiene plastic, ZnS, and $CaWO_4$, the effect increases in the order given. S. T. HENDERSON

778.34 : 539.172

3380. Calculation of the number of events of a certain type, produced in a given volume of nuclear emulsion, from enumeration of the tracks. M. GAILLOUD, C. HAENNY AND R. WEILL. *Helv. phys. Acta*, **27**, *No.* 5, 467–80 (1954) In French.

The mathematical relationships which may be used to calculate the number of nuclear events produced in a given volume of emulsion have been derived, following the various different criteria which may be used for the selective counting of tracks. The conditions for the use of the different criteria are pointed out, together with the advantages and disadvantages of each. P. ROTHWELL

778.34 : 539.18

A note on mass estimation by the range-scattering method. *See Abstr.* 3135